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ELECTRICAL PUMPING IN MINES.

In a paper read before the Iron and Steel Institute at its recent meeting, Mr. D. S. Bigge gives some interesting figures concerning electric pumping in mines. The cases cited show without exception a great saving in the cost of operating by electricity; and in one instance where the prime reason for changing over from the old spear rod to the electric drive was to save space, and the question of fuel was not considered at all, the saving in this latter respect alone will pay for the installation in two years. These figures, to us at least, seem convincing that it is easier and cheaper to transmit electricity along a wire one-half inch in diameter than to move a pump rod eighteen inches square and from two to three thousand feet long.

SURVIVALS IN ELECTRICAL SYSTEMS.

One of our contemporaries calls attention to what seems to be a remarkable survival of one of the early applications of electricity to practical use.

Says this journal: "Nothing in the electrical field has held its own as has the direct-current series arc lighting system. The system of to-day is quite similar to that of the early days of electric lighting. The constant-current machine to-day is very similar to the machine of that time, and the up-to-date series arc lamp differs from the original lamp very little, except that it now generally has an enclosed arc."

At first thought this does seem somewhat striking, but does not further consideration reveal a similar condition for other successful applications of this great civilizing agent? In what essential does the low-voltage incandescent lighting system of to-day differ from that devised by Edison, except in the extent of the system, the size of units, and in the addition of a few auxiliaries which secure better and more economical service?

The trolley system, the extraordinary growth of which has been the cause of much remark and speculation, is practically the same as that installed by Sprague upon the Richmond road in 1887. We still have a series motor on a constant-potential circuit. Here, also, the great development has been in the direction of increase in size and the adaptation of auxiliaries which permit an economical extension of the system.

In what way does the telephone, perhaps the most important of all modern inventions, differ except in details of construction and application from the system devised by Bell?

And the oldest of all the useful applications of electricity, the telegraph, is practically the same in the vast majority of its uses as that devised and put in use by Morse. Has not our wonderful progress during the last fifteen years been rather along the lines of improving the old systems and devising new applications, rather than in replacing the old systems by new?

EFFICIENCY OF THE ELECTRIC FURNACE.

In his paper on the "Efficiency of Electric Furnace Operations" at the recent meeting of the American Electrochemical Society, President J. W. Richards very clearly defined the efficiency of the various types of furnaces. Where electrolytic reaction takes place, the efficiency of this part of the operation is the ratio of the electromotive force theoretically required to that actually found necessary to bring about this reaction.

In defining the efficiency of the thermal operation, the type of furnace must be considered. In the continuous furnace, where there is a continuous supply of raw material and output of finished product, the efficiency of the furnace is the ratio of the useful or unradiated heat energy to the total energy supplied. The only loss here is that due to radiation. The efficiency of these furnaces is improved by well insulating them to prevent this loss and by running the material through rapidly. As a definite temperature must be reached to bring about the desired reaction, and as the heat lost through radiation is a function of time as well as difference in temperature, it follows that the greater the rate of output of a given furnace the higher the efficiency.

A large storage capacity for heat may not be undesirable in this type of furnace, for this will prevent sudden changes in temperature and will be one factor in securing a uniform output, both in quantity and quality of product.

In the intermittent furnace the operation consists in bringing the charge up to the temperature at which the desired reaction takes place, keeping this temperature until the reaction is complete and

then allowing the furnace to cool so that the product may be removed. In this type of furnace the heat radiated after the current is cut off must not be considered as loss, as this was required to bring the charge up to the temperature of reaction. The only losses are those due to radiation at starting and during the flow of current. The efficiency as defined is therefore the ratio, of the difference between the total energy supplied and these losses, to the total energy supplied.

Furnaces of this type should be compact, well insulated thermally, and have a small thermal storage capacity. The last consideration is important, not only because of its effect on the efficiency, but also because a furnace having a small thermal storage capacity can be worked more rapidly than one in which this is greater, as it will sooner reach its final temperature and will cool down more quickly. Strictly speaking, the heat stored up in the walls of the furnace when the current is cut off is a loss, and this should be considered in a comparison of this type with the continuous furnace.

As in the continuous furnace, the efficiency will be increased by working the furnace rapidly, that is to say, bringing it up to the final temperature as quickly as possible.

The difference, so far as efficiency alone is considered, between the two types of furnace then amounts simply to the loss caused by the thermal capacity of the furnace walls. In each case the heat radiated from the finished product can not be considered as a loss, as it is necessary to bring about the reaction.

The results of this study by President Richards show that those furnaces where electrolytic action takes place are the least efficient. Next comes the continuous electric thermal furnace, while the intermittent furnace is the most efficient of all.

This is rather surprising and, we believe, indicates that the first two types of furnace could be improved as regards efficiency. There does not seem to be any reason why the continuous furnace should lose more heat from radiation than the intermittent, unless it is merely a question of size. And as far as regards heat losses, the electrolytic furnace should be on the same footing as the other two, while the direct transformation of electric energy to chemical energy should be at least as efficient as a thermal transformation.

POWER DEVELOPMENTS AT NIAGARA FALLS.

Probably few who have not visited Niagara Falls recently realize the extent of the power developments now going on there. The original American company, the Niagara Falls Power Company, has an output of 50,000 horse-power, while its second power-house, in which the machinery is now being installed, will develop 55,000 horse-power.

The Niagara Falls Hydraulic Power and Manufacturing Company has a present output of 30,000 horse-power. The contemplated enlargement of its canal will make available over 100,000 horse-power. On the Canadian side, the Canadian Niagara Power Company has its tunnel nearly completed, and the first section of the wheel-pit to develop 50,000 of the ultimate 100,000 horse-power has been excavated to about one-third of its final depth, while the Ontario Power Company, which will develop at least the same power, is at work on its intake canal. In addition to these great plants there are several smaller ones on each side of the river.

The incorporation of the new independent telephone company establishes a condition of affairs very similar to the famous three-cornered duel so amusingly described in "Midshipman Easy;" but whether upon closer examination the analogy will hold is another question.

It seems evident that our old and faithful friend, the series motor, is still to be with us for some years to come. Now, however, it is to be taught to perform gracefully the old trick of operating on an alternating-current circuit.

The ELECTRICAL REVIEW extends its greetings to the American Street Railway Association which meets in Detroit next week. That the convention will be successful is assured by the ability and energy of the officers. This association is a thoroughly representative one.

ELECTRIC AUTOMOBILES.

We learn with regret that but one electric automobile has been entered in the reliability run between New York and Boston, which will be held October 9-15.

The conditions of the contest seem particularly suitable to electric machines. Charging or exchanging batteries is allowed in the morning and at noon. High speeds are not allowed, so that wear and tear on the batteries should be slight. The longest half-day run, from Springfield to Worcester, is but fifty-two miles.

We think there is no doubt that there are a number of electric vehicles which could meet these conditions successfully. Electric wagons are widely used in the large cities, and it is reported that long and careful records of these vehicles have been kept by a Brooklyn firm, which records demonstrate the entire success of these machines for their work.

Electric propulsion has demonstrated its superiority in railway work and will surely do the same in other classes of transportation.

There can be no question but that the horse, as a means of transportation in cities, must be abandoned.

Doubtless the demand for electric carriages has been retarded by the prevailing idea that, due to the necessity of charging, these machines have but a limited range of travel. We think, however, that a careful study of any district would show a much greater range than is generally supposed. Now, would it not be a good plan for the makers of electric vehicles to compile a guide-book showing all the stations in the country where these machines could be charged? We believe such a guide would show possibilities of travel far greater than are generally assumed, and would be a convincing reply to criticism in this respect. With this objection disposed of, the battle is more than half won.

It has been said that the demand for automobile batteries is so small that the accumulator manufacturers are making no efforts to build it up. This is not the proper spirit, however, as the same criticism could be made of any new industry.

We have no doubt of the final triumph of the electric automobile, and believe that with proper attention the business could be made a very profitable one.

American Institute of Electrical Engineers.

Opening Fall Meeting Held in New York City, September 26, 1902.

THE first fall meeting of the American Institute of Electrical Engineers was held in New York city, Friday evening, September 26. Mr. C. P. Steinmetz, the retiring president, introduced his successor, Mr. C. F. Scott. After a report by the secretary, Mr. Scott addressed the Institute.

The subject of Mr. Scott's address was the "Proposed Developments of the Institute." Before entering upon the routine of regular work he suggested that a pause be made to consider the functions of the Institute, its present status and its future possibilities.

The position occupied by the electrical engineer, he thought, is unique; the science underlying his work is the most fascinating and fruitful. The applications of electricity are almost universal, there being scarcely a branch of human activity that has not received a quickening touch. So rapidly have electrical developments advanced that a new branch of engineering is now upon us. The scope of electrical engineering has progressed from trivial beginnings until it includes works of the greatest diversity and magnitude. He spoke at length of the field that was open for the application of electrical appliances. This development has not been the result of mere chance, but of a combination of favoring conditions.

While the theme, "the infancy of electricity" has become a hackneyed one, the electrical engineer must realize how brief, compared with other branches of engineering, is the experience upon which his work is based. Even the oldest of electrical inventions, the telegraph, had its beginning when men now living were well-grown boys.

The past fifty years, and notably the past decade, have witnessed a general activity of such magnitude that it marks an epoch in the world's history. In this development electricity has been foremost.

Considering the financial aspect, it has been estimated that the total investment in electrical applications, outside of telegraphy and telephony, at the time the Institute was founded, did not exceed $1,000,000. At the present time the estimated capitalization of electrical applications in the United States approximates $4,000,000,000. Even these figures, although they indicate the vast responsibilities which are entrusted to the electrical engineer, do not fully measure that responsibility, since they take no account of many applications of electrical apparatus in a subsidiary or auxiliary way.

The president then spoke upon the generally prosperous conditions obtaining in the United States. Continued prosperity, he thought, required high efficiency. Efforts must not be wasted or dissipated. A great responsibility rests upon the intellectual classes. As a factor in maintaining prosperity, the work of the electrical engineer is of great consequence. Applied electricity so increases the efficiency of industrial and commercial life that better results and higher efficiency can be secured with a given expenditure of energy.

Electrical interests are so diversified and so extended that electrical workers should be brought together. They should have a common meeting place. Here discoveries may be announced, inventions described, engineering schemes criticised and new undertakings presented and discussed. Here the student and professor, the investigator, the inventor, the manufacturer, the operator and the consulting engineer may meet upon common ground. The engineer who is tempted to ridicule scientific work finds that it is the foundation upon which his own work rests. The professor who regards slightingly the work of the designing or constructing engineer may find that his own cherished formulæ are derived from the rules and contain the constants which the practical man has determined for himself.

It is the function of the American Institute of Electrical Engineers to bring individual workers into a common unity —to join them in a unity of interests which is called the electrical engineering profession. It is the function of the Institute to continually bring together the diversified achievements of many workers, which, taken all together, constitute a single total of accomplishment. It is the function of the Institute to take the lead in such measures as will promote the general interest of the profession and the efficiency of electrical work. He then went on to relate the prominent part which the American Institute of Electrical Engineers has taken in representing the profession in various ways.

In discussing the future of the Institute, Mr. Scott thought the membership should be increased, the power and influence of the Institute being dependent upon the number, character and activity of its members. There are many engineers eligible to membership who are not members because they do not fully appreciate the scope and work of the Institute. During the past year the membership increased twenty-five per cent and reached a total of 1,546. This is less than one-half the membership of the British Institution of Electrical Engineers. If the American Institute membership bore the same relation to the kilowatt capacity of the electrical power stations of the country, as does that of the British institution, the membership of the American Institute of Electrical Engineers should be 25,000.

In discussing the question of papers and contributions, he suggested that a larger proportion of the membership take a positive part. While the Institute as a body is not responsible for the statements or opinions of its members, there is, nevertheless, an obligation resting upon its members not to leave unchallenged inaccurate and misleading statements. An examination of the last volume shows that five per cent of the membership took part in the meetings, and that two per cent furnished papers. Of these, five per cent came from miscellaneous sources, twenty per cent from college professors, twenty-five per cent from operating and consulting engineers and forty-five per cent from engineers connected with manufacturing companies. These figures indicate that electrical matters are advancing so fast that even the teachers in the great technical schools fall behind, because the problems come first with the manufacturers. To the manufacturing companies must be given credit for substantially advancing scientific investigation, as well as practical development.

While the monthly meetings are held in New York city, where most of the members reside, only one-fifth of the papers presented were by New York

members during the last season. The Institute is national in its scope, and there should be an effort among the membership to increase the quantity, as well as the quality, of its published proceedings. Local committees of the Institute in various cities would broaden the influence of the work and generally extend its benefits.

The proper education of the engineer is a problem to which various solutions are offered. All, however, will doubtless agree that the profession has already reached a stage, and is advancing so rapidly, that the purely "practical" man can not hope to maintain himself in the front rank. The rate at which development is progressing demands a thorough grounding in fundamental principles, in order to impart the power for grasping and meeting new conditions.

His predecessor, he said, spoke truly when he remarked that the educational institutions should give the young man "a thorough understanding of the fundamental principles of electrical engineering and allied sciences, and a good knowledge of the methods of dealing with engineering problems." The best education, he said, is that in which theoretical training in fundamental principles predominates. The true function of practical work in a broad engineering education is not to produce skilled workmen or full-fledged engineers, but it is to supplement theoretical work, making it definite and certain, so that the student may properly assimilate the instruction which he receives.

The collection of engineering data in the establishing of standard practice in electrical engineering is one of the important functions of the Institute. The present years are formative years; electrical engineering is crystallizing; electrical theories and laws and electrical measurements are more definite than those relating to the allied professions. Electrical engineering practice, however, is now being established. The apparatus and the methods, both in detail and in general, which characterize present work, are radically different from those of five or ten years ago. General investigations should be made in various lines of electrical engineering work, not primarily for the purpose of devising theoretical standards or undertaking original investigation, but for the purpose of determining what is best in present practice, and of formulating and crystallizing it into what may be recognized as standard practice.

The electrical engineer must not fail to realize the value of standards. In Europe to-day there is a confusion of systems and frequencies and voltages, and a wide diversity in types of construction. Many foreign engineers pride themselves on devising that which is novel instead of adopting that which is standard.

The United States, with only one-fifth the population of Great Britain and Europe, has two and one-third times the kilowatt capacity in power stations in electric railways, and three and one-half times the mileage of electric railways. The power-houses in operation and under contract in New York city would replace all the central stations for lighting and power in Great Britain or in Germany. They would operate all the electric railways of Great Britain and Europe combined. One alone would be sufficient for the railways of Germany, and the output of a single generator would run all the railways of Switzerland. American designs, methods and practice are being introduced into half a dozen factories in foreign countries.

Electrical progress and leadership can be promoted by the Institute, as it draws together and unites the efforts of electrical workers, and it aids in establishing the standards of the future.

He then spoke upon the merited support which should be given to the library, dwelling upon the generous assistance of Dr. S. S. Wheeler in his work in connection with the Latimer Clark Library as a foundation. Mr. Carnegie's contribution has enabled the library to be catalogued and otherwise made more useful. Various members and different corporations and scientific societies had contributed valuable sets of books, such as proceedings of scientific societies, records in patent litigation and the like. At least one member has provided by his will that a part of his technical library shall pass to the Institute, and another is proposing an endowment for the future continuation of the sets which he has presented. The policy decided upon by the library committee is to place upon the shelves of the Institute every book relating to electricity in the English language, and every book of value in the French, German and other languages. The several thousand volumes of rare books which are now available is a magnificent beginning.

At this point Mr. Scott announced that a communication from the chairman of the library committee might be read. This announced a large gift to the library by Mr. C. O. Mailloux of a number of valuable sets of journals and transactions. This is accompanied by a sum of money, the annual income of which will be sufficient to pay for future subscriptions to those periodicals which are yet current, and also to cover the cost of binding the completed volumes.

Permanent quarters for the Institute should be an object of plans and anticipations, continued Mr. Scott. Such an organization as this should not be hampered for want of the most convenient accommodations. Personal acquaintance and social intercourse are initial factors in unity of sentiment and of action, and the library should be speedily rescued from its all but inaccessible and cramped quarters.

Cooperation with similar institutions in other countries will be mutually beneficial in various ways. It is the hope and expectation of the Institute to have as its guest within the next few years the Institution of Electrical Engineers of Great Britain. The scope of the profession is world-wide, and the Institute should welcome the coming opportunity to extend its acquaintance and broaden its ideas.

At the close of his address, Mr. Scott introduced Mr. B. G. Lamme, who read his paper on the "Washington, Baltimore & Annapolis Single-Phase Railway." In the discussion of this paper, Mr. C. P. Steinmetz said that it was a cause for congratulation that American engineering was still in the lead. In Europe all efforts have been directed to adapting a motor known to be unsuitable to railway work. In this country, however, a motor of suitable characteristics was being developed. The use of the series motor on alternating-current circuits was not new, but heretofore it has been impossible to prevent disastrous sparking and to secure a suitable power-factor. He expects more, however, from the Thomson repulsion motor. The characteristics of the induction motor are similar to those of the shunt motor, while those of the repulsion motor resemble the series motor. The use of these motors at a high speed and low frequency is doubtless one of the elements of success.

Mr. R. D. Mershon reasserted his faith in the induction motor, and stated his belief that although the characteristics of this machine were similar to those of the direct-current shunt motor, the future development of the induction motor will enable it to be used successfully in railway work.

Professor W. E. Goldsborough expressed his confidence for a final successful application of the single-phase alternating-current motor, but thought that for some time the conditions would be similar to those obtaining during the early development of electric traction. At present no one could say what system would be successful, but he believed that within a few years methods would be crystallized, and that there would then

be a standard alternating-current single-phase railway equipment.

Mr. B. J. Arnold said that much credit was due to the engineers who were developing this new system. The problem, he thought, could be summed up as simply one of commutation. He also called attention to the work which has already been done to apply alternating-current motors to railway work. He had taken a contract in December, 1899, to equip a sixty-mile road with an alternating system, and that the construction and equipment of the road were now well advanced. He had been advocating the use of alternating-current motors for railway work for the past three years, and was now glad to have more company in his opinions than had hitherto been the case.

Mr. H. A. Wagner expressed his faith in the single-phase motor. His experience, however, had led him to believe that there was a great future for the repulsion motor. Sparking can be overcome at low frequencies and by suitable design.

Mr. C. O. Mailloux, while recognizing the excellent results which had been obtained with these series motors, expressed himself as being still somewhat skeptical —or rather conservative—as to their actual success in practical applications. Other systems seemed to him more promising, and he still had a firm belief in the direct-current motor.

The discussion was continued by Messrs. W. S. Franklin, E. E. Ries and others, opinions being expressed that the problem was one of commutation and design, and various questions relating to these points were asked. Attention was also called to the great decrease in frequency which has been going on since the introduction of alternating-current apparatus.

Mr. Lamme, in his reply, stated that 100-horse-power motors have been in operation at the Westinghouse company's factories for some time past. They have been found to be entirely reliable and satisfactory. The apparatus to be used was not a proposed type, but one which had been in actual operation. Of the two types of motors, he believed that the series motor had decided advantages over the repulsion motor. In the case of the latter, the question of reversing the direction of rotation was a troublesome feature. Although this system might be said to be a return to an old type, it was doing what had never been done before. Into the question of design many points entered. The air-gap used was practically the same as that with a similar direct-current motor. No lead was given to the brushes, and therefore no shifting was necessary. The number of poles had little effect upon the power-factor. The further details of the motor, while they could not be disclosed at present, would be presented in a future paper before the Institute.

At the conclusion of the discussion, on the motion of Mr. C. P. Steinmetz, the thanks of the Institute were tendered to Mr. C. O. Mailloux for his liberal additions to the Institute library.

WASHINGTON, BALTIMORE & ANNAPOLIS SINGLE-PHASE RAILWAY.*

BY B. G. LAMME.

The Washington, Baltimore & Annapolis Railway is a new high-speed electric line extending from the suburbs of Washington to Baltimore, a distance of about thirty-one miles, with a branch from Annapolis Junction to Annapolis, a distance of about fifteen miles. The overhead trolley will be used, and schedule speeds of over forty miles per hour are to be attained. This road is to be the scene of the first commercial operation of an entirely new system of electric traction.

The special feature of this system is the use of single-phase alternating current in generators, transmission lines, trolley car equipment and motors.

It constitutes a wide departure from present types of railway apparatus, and while retaining the best characteristics of the present standard direct-current motor system, the use of alternating current makes it possible to avoid many of the bad features.

The standard direct-current railway equipment possesses several characteristics which fit it especially for railway service. These characteristics have been of sufficient importance to overbalance many defects in the system. In fact, a far greater amount of effort and engineering skill has been required for overcoming or neutralizing the defects than for developing the good features possessed by the system. By far the most important characteristic possessed by the direct-current system is found in the type of motor used on the car. The direct-current railway motor is in all cases a series-wound machine. The series motor is normally a variable field machine, and it is this feature which has adapted the motor especially to railway service. Shunt-wound motors have been tried and abandoned. All manner of combinations of shunt, series and separate excitation have been devised and found wanting, and in many cases the real cause of failure was not recognized by those responsible for the various combinations. They all missed to a greater or less extent the variable field feature of the straight series motor.

It is true that a variable field can be obtained with shunt or separate excitation, but not without controlling or regulating devices, and the variation is not inherently automatic, as in the series motor. Polyphase and single-phase induction motors do not possess the variable field feature at all, as they are essentially constant-field machines. They are equivalent to direct-current shunt or separately excited motors, with constant field strength, which have been unable to compete successfully with the series motor.

The variable field of the series motor makes it automatically adjustable for load and speed conditions. It also enables the series motor to develop large torques without proportionately increased currents. The automatically varying field is accompanied by corresponding variations in the counter-electromotive force of the armature until the speed can adjust itself to the new field conditions. This feature is of great assistance in reducing current fluctuations with a small number of steps in the regulating rheostat. Any increase in current, as resistance is cut out, is accompanied by a momentary increase in the counter-electromotive force, thus limiting the current increase to a less value than in the case of a constant field motor.

Next to the type of motor, the greatest advantage possessed by the direct-current system lies in the use of a single current or circuit, thus permitting the use of one trolley wire. The advantages of the single trolley are so well known that it is unnecessary to discuss them. For third-rail construction, the use of single current is of even greater importance than in the case of the overhead trolley. It is seen, therefore, that it is not to the direct current that credit should be given for the great success of the present railway system, but to the series type of motor and the fact that up to the present time no suitable single-phase alternating-current motor has been presented.

Some of the undesirable features of the direct-current railway system should also be considered. The speed control is inefficient. A nominally constant voltage is supplied to the car, and speed control is obtained by applying variable voltage at the motor terminals. This variation is produced by the use of resistance in series with the motors, with a loss proportional to the voltage taken up by the resistance. By means of the series-parallel arrangement, the equivalent of two voltages is obtainable at the motor terminals without the use of resistance. Therefore, with series-parallel control, there are two efficient speeds with any given torque, and with multiple control there is but one

* A paper presented at the 168th meeting of the American Institute of Electrical Engineers, New York, September 26, 1902.

efficient speed with a given torque. All other speeds are obtained through rheostatic loss, and the greater the reduction from either of the two speeds, series or parallel, the lower will be the efficiency of the equipment. At start the rheostatic losses are always relatively large, as practically all the voltage of the line is taken up in the rheostat. For heavy railroad service, where operation for long periods at other than full and half speeds may be necessary, the rheostatic loss will be a very serious matter.

The controlling devices themselves are also a source of trouble. An extraordinary amount of time and skill has been expended perfecting this apparatus. The difficulties increase with the power to be handled. The controller is a part of the equipment which is subjected to much more than ordinary mechanical wear and tear, and it can go wrong at any one of many points. The larger the equipment to be controlled the more places are to be found in the controller which can give trouble. The best that can be said of the railway controller is that it is a necessary evil.

Another limitation of the direct-current system is the trolley voltage. Five hundred volts is common at the car and 650 volts is very unusual. By far the larger number of the railway equipments in service to-day are unsuited for operation at 600 volts, and 700 volts in normal operation would be unsafe for practically all. The maximum permissible trolley voltage is dependent upon inherent limitations in the design of motors and controllers. The disadvantages of low voltage appear in the extra cost of copper and in the difficulty of collecting current. In heavy railroad work the current to be handled becomes enormous at usual voltages. A 2,400-horse-power electric locomotive, for example, will require between 3,000 and 4,000 amperes at normal rated power and probably 6,000 to 8,000 amperes at times. With the overhead trolley these currents are too heavy to be collected in the ordinary manner, and it is a serious problem with any form of trolley or third-rail system which can be used. It is evident that for heavy service, comparable with that of large steam railways, a much higher voltage than used in our present direct-current system is essential, and the use of higher voltage is destined to come, provided it is not attended by complications which more than overbalance the benefits obtained.

A further disadvantage of the direct-current system is the destructive action known as electrolysis. This may not be of great importance in interurban lines, chiefly because there is nothing to be injured by it. In city work its dangers are well known, and very expensive constructions are now used to eliminate or minimize its effects.

From the above statements it is evident that an alternating-current railway system, to equal the direct current, should possess the two principal features of the direct-current system, *viz:* A single supply circuit and the variable field motor, and to be an improvement upon the direct-current system, the alternating current should avoid some of the more important disadvantages incident to the present direct-current railway apparatus.

The system must, therefore, be single-phase. The importance of using single-phase for railway work is well known. The difficulties and complications of the trolley construction are such that several alternating-current systems have been planned on the basis of single-phase supplied to the car, with converting apparatus on the car to transform to direct current, in order that the standard type of railway motors may be used. Such plans are attempts to obtain the two most valuable features of the present direct-current system. The polyphase railway system, used on a few European roads, employs three currents, and therefore does not meet the above requirement.

The motor for the alternating-current railway service should have the variable speed characteristics of the series direct-current motor. The polyphase motor is not suitable, as it is essentially a constant-field machine, and does not possess any true variable speed characteristics. Therefore it lacks both of the good features of the direct-current railway system. A new type of motor must therefore be furnished, as none of the alternating-current motors in commercial use is adapted for the speed and torque requirements of first-class railway service. Assuming that such a motor is obtainable for operation on a single-phase circuit, the next step to consider is whether the use of alternating instead of direct current on the car will allow some of the disadvantageous features of the direct-current system to be avoided.

The direct-current limits of voltage are at once removed, as transformers can be used for changing from any desired trolley voltage to any convenient motor voltage. Electrolysis troubles practically disappear. As transformers can be used, variations in supply voltage are easily obtainable. As the motor is assumed to have the characteristics of the direct-current series motor, speed control without rheostatic loss is practicable when voltage control is obtained. This combination, therefore, allows the motor to operate at relatively good efficiency at any speed within the range of voltage obtained. If the voltage be varied over a sufficiently wide range, the speed range may be carried from the maximum desired down to zero, and, therefore, down to starting conditions. With such an arrangement no rheostat need be used under any conditions, and the lower the speed at which the motor is operated, the less the power required from the line. The least power is required at start, as the motor is doing no work and there is no rheostatic loss. The losses at start are only those in the motor and transforming apparatus, the total being less than when running at full speed with an equal torque. Such a system, therefore, permits maximum economy in power consumed by motor and control. This economy in control is not possible with the polyphase railway motor, as this motor is the equivalent of the direct-current shunt motor, with which the rheostatic loss is even greater than with the series motor.

The use of alternating current on the car allows voltage control to be obtained in several ways. In one method a transformer is arranged with a large number of leads carried to a dial or controller drum. The Stillwell regulator is a well-known example of this type of voltage control. This method of regulation is suitable for small equipments with moderate currents to be handled. The controller will be subject to some sparking, as in the case of the direct-current apparatus, and, therefore, becomes less satisfactory as the car equipment is increased in capacity. Another method of control available with alternating current is entirely non-sparking, there being no make-and-break contacts. This controller is the so-called "induction regulator," which is a transformer with the primary and secondary windings on separate cores. The voltage in the secondary winding is varied by shifting its angular position in relation to the primary. With this type of voltage controller very large currents can be handled, and it is especially suitable for heavy equipments, such as locomotives.

It is thus seen that there is one method of control available with alternating current which avoids the inherent troubles of the direct-current controller. The induction regulator is primarily a transformer, and all wear and tear is confined

(*Continued on page 454.*)

The Electrolytic Manufacture of Chlorates—I.

By John B. C. Kershaw, F. I. C.

INTRODUCTORY.

WHEN free chlorine gas is led into a solution of potassium or sodium hydrate, the following reactions can occur:

(1) $2KOH + Cl_2 = KClO + KCl + H_2O$.

(2) $6KOH + 3Cl_2 = KClO_3 + 5KCl + 3H_2O$.

The first reaction, in which hypochlorite is the chief product, occurs at temperatures below twenty degrees centigrade; the second, in which chlorate is produced, at temperatures above thirty degrees centigrade.

The ordinary chemical method of producing chlorates worked out by Liebig, and used on a very extensive scale in the chemical works of the United Kingdom and of France down to the present date, depends upon the second of these reactions. Chlorine gas is generated in the customary manner, from hydrochloric acid and manganese dioxide. This gas is led into milk of lime at a temperature above thirty degrees centigrade, and the clear solution of chlorate of lime which is produced is concentrated, and then decomposed with potassium chloride. The substitution of calcium hydrate for potassium hydrate is simply a device to avoid the loss of the latter as potassium chloride in the primary chemical reaction with the chlorine gas.

Chlorine and caustic alkali are, however, products of the electrolytic cell, and if one modifies the usual method of decomposing the alkali metal chlorides by electrolysis, so that the products can react with one another in the cell, one obtains either hypochlorites or chlorates, according to the temperature of the cell solution, at the surfaces of the two electrodes.

The earliest reference to the possibility of forming chlorates by the electrolysis of the alkali metal chlorides on an industrial scale of operations is contained in British Patent No. 13,755, of 1851.* This patent, granted to Charles Watt over fifty years ago, described the conditions necessary to produce chlorate by electrolysis of solutions of sodium or potassium chloride. Watt had discovered that a high temperature and an alkaline solution favored the formation of chlorate in the cell, and he recommended the use of steam-jacketed cells and of horizontal electrodes with the anode below. This patent contains the essential ideas of all the later processes, but it was never worked on a practical scale owing to the excessive cost of electrical power in the middle years of the century. It was not until electric lighting had developed into a large and important branch of the engineering industry that dyamos reached their limits of improvement, and that the application of water power for generating electric energy became a practical possibility. The period 1850-1890 was therefore one of preparation for the later industrial developments.

*Stadion is said to have *observed* the formation of chlorates in the electrolytic cell in 1816.

THE GALL AND MONTLAUR CHLORATE CELL AND PROCESS.

The first practical attempt to carry out the ideas contained in the 1851 patent granted to Charles Watt was made by two Frenchmen—MM. Gall and Montlaur—in 1889; a small factory being erected in that year at Villers-sur-Hermes, in Switzerland. The process and cell described in the Gall and Montlaur British Patent No. 4,686, of 1887, were operated at this works. The trials were successful, and in 1890-1891 a larger factory was erected at Valorbes, in Switzerland, where 3,000 horse-power had been developed for industrial use. Fig. 1 is a view of these works and of the falls. The following is the description of the Gall and Montlaur process and cell, as given in the 1887 patent:

The chloride in aqueous solution is submitted to the action of an electric current in a trough provided with a porous partition. The trough may be of earthenware, stoneware or other convenient material, being divided into two parts by the porous diaphragm, which may be of porous earthenware, pasteboard or any other suitable material not containing organic or other substances liable to be destroyed by chloric acid.

To avoid the reducing action of the hydrogen which is separated at the negative pole, the liquid in the negative compartment is caused to circulate, by exterior tubes with valves or other suitable means, toward the positive compartment, so that the base formed may combine with the chloric acid as it is formed. The base derived from preceding operations may likewise be introduced into the positive compartment at the commencement of the operation.

The solution is preferably kept at a temperature of from fortv-five to fifty-five degrees centigrade during the process, and the reaction then takes place according to the equation:

$6Cl + 6MOH = MClO_3 + 5MCl + 3H_2O$.

M representing a monovalent radical.

The electromotive force of the current should be of a strength corresponding to the affinity of chlorine for the corresponding metal, and may be reckoned by the thermochemical tables of Berthelot, thus 4.34 volts for chlorate of potash.

The quantity of current may vary within wide limits, fifty amperes per square decimetre of electrode is a suitable amount.

For the positive electrode, platinum or an alloy of platinum and ten per cent iridium is most convenient; for the negative electrode iron or, preferably, nickel may be employed. The temperature of the liquid may be maintained by heating the same by means of a spiral or tubing of platinum passing through the trough.

The Valorbes factory is still operating, and is stated to be producing about 1,500 tons of chlorate per annum. The following details of the works and process as originally carried on are based upon the article in the paper named below.*

The electrolytic cells are large rectangular vats having a capacity of 1,765 cubic feet. They are apparently built of wood, although there is no definite statement to this effect. They are insulated from the floor of the building by porcelain cups filled with oil, in order to lessen the danger to the workmen. There are 270 of these vats at Valorbes; half of this number are constantly in operation. The anodes and cathodes are placed at the bottom of the vats, the anode being placed lowest, and a porous partition of earthenware divides these vats into anode and cathode chambers. Lunge states that these diaphragms are of special form, and doubtless the long experience this company has had will have led to improvements in the structure and composition of this very troublesome element in cell construction.

The anodes are very thin (one millimetre) sheets of an alloy of ninety per cent platinum and ten per cent iridium, which is found to stand the action of the chlorine better than platinum alone. The cathodes are plates of iron or nickel; the

*"La Lumiere Electrique," p. 101, 1891.

latter is best. The cell is worked with a twenty-five per cent solution of potassium chloride, which is kept in constant circulation from the cathode toward the anode compartment of the vat through external pipes. The current density used is 465 amperes per square foot, and the electromotive force required to produce this, under the above conditions, is five volts. This high current density is required in order to keep the vat solution at the necessary temperature of forty-five degrees to fifty-three degrees centigrade. The potassium chlorate, first produced in the anode chamber, remains dissolved in the solution, but as the electrolysis proceeds it crystallizes out in the well-known form, the salt being less soluble in water than in solutions of potassium chloride. The vat contents are run off every few hours; the chlorate crystals are separated from the liquid, and the solution, after restoration to its original strength by addition of fresh potassium chloride, is returned to the electrolyzing vat. The potassium chloride used in the process is so pure that the same volume of water may be used in the process for several weeks before the impurities have collected in sufficient amount to exercise a disturbing influence upon the manufacture.

The presence of metallic oxides in the solution is most to be dreaded, since these decompose the hypochlorite into chloride and free oxygen, and thus effectually prevent the formation of chlorate. The chlorate obtained at Valorbes is recrystallized before it is placed upon the market.

FIG. 1.—VALORBES CHLORATE WORKS, SWITZERLAND, 3,000 HORSE-POWER.

The water-power plant at Valorbes cost $49,920, and the electrical plant $65,280. The Société D'Electrochimie, of Paris, the company owning the Gall and Montlaur patents, having proved that the process operated successfully at Valorbes, built a second chlorate factory at St. Michel, in Savoy, in 1894. At this works between 3,000 and 4,000 horse-power is available for the manufacture. Fig. 2 shows a bird's-eye view of the works and of their surroundings. The two pipe lines clearly seen in this view are 330 yards in length and forty-seven inches in diameter; they give a head of 230 feet at the turbine house. The water is taken from the River Arc, at a point in the Maurienne Valley, one and one-half miles above the chlorate factory, and this water is conveyed by a tunnel one and one-quarter miles in length to the forebay at the head of the pipe lines. The turbine house contains twelve 200-horse-power and four 400-horse-power turbines, direct-coupled to Thury dynamos, of equivalent power. Fig. 3 gives an interior view of the power-house at St. Michel.

FIG. 2.—GENERAL VIEW OF THE ST. MICHEL CHLORATE WORKS, SAVOY, FRANCE.

The Gall and Montlaur chlorate process, as operated at Valorbes and St. Michel, has undergone modifications and improvements since 1894, and it is reported that diaphragms are now dispensed with, and that the formation of chlorate is allowed to proceed in the open cell. The results obtained in recent laboratory investigations upon the chemistry of the electrolytic chlorate cell have shown that the presence of chromates and of hydrochloric acid, in the electrolyte, increases the yield of chlorate in a remarkable manner. It is believed that the Société D'Electrochimie has adopted these new methods of working the cell in the factories at Valorbes and St. Michel. As originally worked, the output of chlorate by the two works was about 1,800 tons per annum. In 1900 the Valorbes factory is reported to have produced 1,500 tons chlorate, so that the combined output of the two factories is probably now over 3,000 tons per annum. Owing to the increase of competition in the electrolytic chlorate industry the pioneer company has naturally grown rather chary about publishing details of its procedure, and figures for its annual output and official confirmation on some points can not be obtained.

THE CARLSEN CHLORATE CELL AND PROCESS.

This patented procedure for the manufacture of chlorates has been operated at Mansboe, in Sweden, since 1894, but few details of the cell or process are available for publication. The Swedish patent is

No. 3,614 of the year 1890, and the process, of course, in its main features, resembles that of Charles Watt. An alkaline electrolyte is reported to be in use, with an open type of cell. The head of water available is thirty-seven feet, and twenty turbines are installed, running at 180 revolutions per minute. The dynamos are six-pole machines, and are direct-coupled to the turbines. They yield under normal running conditions 1,200 amperes at 115 volts. The capacity of the generating plant is therefore 2,760 kilowatts, equal to 4,500 horse-power. The capital outlay upon the plant was 170 kroners per horse-power, and the running charges, inclusive of rent and interest, amount to from seven to ten kroners per horse-power (year).* The original installation at Mansboe produced 690 tons chlorate per annum with 1,760 horse-power, but the works have been enlarged since 1894, and now utilize the whole of the power and produce over 1,300 tons chlorate per annum.

The installation of plant and machinery is reported to have cost £40,000, while an equal amount was expended upon developing the water power.

A second chlorate factory has been started at Alby, in Sweden, where 1,200 horse-power is available, but no details of the process used have yet been published.

FIG. 3.—THE GENERATING MACHINERY AT THE ST. MICHEL CHLORATE WORKS, SAVOY, FRANCE.

* "Teknisch. Tidskrift," 1895.

Losses in a Large Asynchronous Motor.

A recent article in a German contemporary by Mr. F. Bodensteiner gives the results of a very careful study of a large, slow-speed, three-phase induction motor. The motor, which is rated at 125 horse-power and operates at 500 volts and sixty revolutions per minute, was built for mine pumping. The dimensions and weights of the principal parts are given. The separation of the various losses in asynchronous motors is important in the consideration of design and construction, and various methods for accomplishing this have been described of late. The application of several of these methods is considered, and it is shown that they can not always be relied upon. Thus, Benischke's method of determining the mechanical effort gives results varying from those obtained by Hissink's method. In the case of this motor, however, the specific bearing pressure is much less than the normal, as given by Dettmar, and the usual allowance for wear and tear on the journals is found not to be necessary. A study of the retardation curves also gives results varying from those determined by actual measurement, and from this the conclusion is drawn that interpolation by means of produced characteristics is not allowable. Tests conducted by the brake methods also show the unreliability of the retardation curve method for the separation of losses in an excited asynchronous motor.

The Honolulu Rapid Transit and Land Company, Honolulu, Hawaiian Islands.

For the past sixteen years or more the Hawaiian Tramways Company has given Honolulu horse-car service from the business to the residence districts and to the bathing beach at Waikiki. A franchise was given to this company to install an electric system, but as it did not avail itself of the opportunity, lead to the organization of the Honolulu Rapid Transit and Land Company. Inasmuch as the Hawaiian Tramways Company occupied the principal streets, made it very difficult to secure routes consistent with the requirements of the traveling public.

By referring to a map of Honolulu it will be seen that there are only two thoroughfares from Nuuanu River going east and only one main road in a westerly direction. The roads from the numerous valleys lead to the main roads. The latter roads are occupied by the Hawaiian Tramways Company, and as it claims exclusive franchise, many lawsuits have been instituted and are now in the courts for final judgment.

The map of Honolulu will give an idea of the layout, but it can not emphasize the tortuous and narrow streets.

After many vexatious delays a single-track line of four and one-half miles was completed and ready for operation. One extremity of this line is on Wilder avenue, at Alexander street, in Punohon, a residence district, and runs along Wilder, Pensacola, Lunalilo, Alapai and Hotel streets to Fort street, the business centre, this distance being 2.5 miles. This line then continues on Hotel street and King street to Liliha street, passing continuously through Chinatown and then out Liliha to Wyllie street. The distance from the business centre to Wyllie street is two miles. The Liliha street part of the line is practically a continuous ascent from an elevation of ten feet above sea level to an elevation of 235 feet with a maximum grade of seven per cent. The remaining part of the line is ascent and descent and the extremes of elevation are five feet and eighty-four feet.

This line was opened for traffic on Saturday afternoon, August 31, 1901. The opening was in every way a perfect success, not a hitch occurring or accident happening to mar the event of a new epoch in Honolulu. The next day there were collected over 9,000 fares, and as the conductors were inexperienced and the cars packed, undoubtedly many more passengers were carried than the fares indicated. Six cars were used in this service, running on a headway of ten minutes.

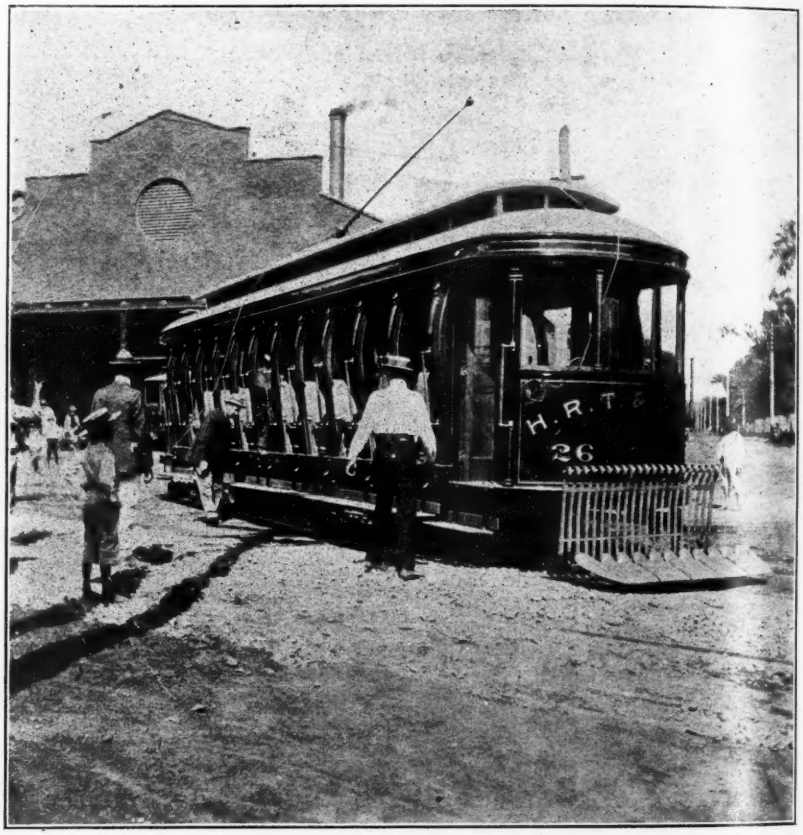
On October 31, 1901, 1.9 miles additional track were thrown open to the public. This line extends from Wilder avenue and Punahon, at an elevation of sixty-six feet, thence up Punahon street and Manoa road to and through College Hills, a subdivision that lays in the Manoa Valley. The first 3,000 feet of this line rise to an elevation of 215 feet, with a maximum grade of seven per cent.

On December 8, 1901, another extension was thrown open to the public. This line runs from King and Liliha streets, thence along King street to Kamehameha IV road in Kalihi, a distance of 1.9 miles. A portion of this distance parallels the horse-car line.

On June 22, 1902, a line of 1.2 miles was added to the system. This line parallels the horse-car line on King street from Alapai street to the Waikiki road, and on July 12, 1902, the service had an addition of 0.7 mile extending from Alapai street to Fort street, on King street. The line on King street is now being extended from Fort street to Liliha street, a distance of 0.7 mile. This King street line will be extended from its eastern terminus to Waikiki Beach, and to and through Kapiolani Park as soon as the necessary right of way can be obtained. This additional distance will be about three miles.

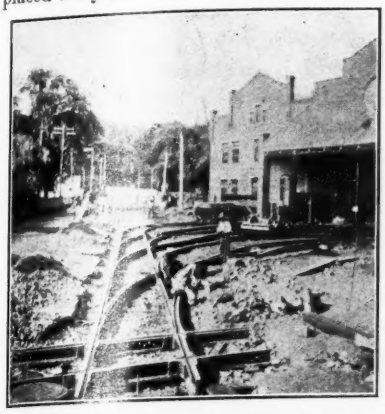
When certain obstacles are removed a line will be built from Fort street along the Esplanade, Alakea, Emma, Punchbowl, Kuikini and Nuuanu streets to Bates street, where a connection may be made with an electric car line to Pacific Heights, which line reaches an elevation of 800 feet. The power for this Pacific Heights line is now furnished by the Honolulu Rapid Transit and Land Company, but the road is owned by another corporation. A beautiful view is obtained from these heights, showing Honolulu at your feet and the crater of the extinct volcano Punchbowl 300 feet below.

The effort of the company has been toward good construction. The foundation of the track consists of six inches of broken stone thoroughly rolled with a fifteen-ton steam road roller. On this is placed cedar ties six inches by eight inches by six feet, being thirteen to each thirty feet. On each tie is placed tie-plates which support an eighty-five-pound girder rail seven inches deep. These rails



ONE OF THE CONVERTIBLE CARS ON THE LINE OF THE HONOLULU RAPID TRANSIT AND LAND COMPANY.

are coupled together by twenty-six-inch splice bars fastened by eight bolts. The rails are spiked to each tie with six spikes, three at each rail. The two parallel lines of rails are tied together by a tie rod placed every six feet. These rods are one-



TRACKS ENTERING CAR BARN, HONOLULU RAPID TRANSIT AND LAND COMPANY.

eighth-inch by one and three-quarter inches, and rounded and threaded at each end to a diameter of nine-sixteenths of an inch. Four nuts are placed on each rod, two bearing against the inside of the rails and two on the outside.

The rail joints are bonded together by two 4/0 protected copper rail-bonds. The holes for the bonds are reamed out until a bright surface is obtained and the bond terminals placed therein and compressed by a screw compressor operated by a six-foot lever. Every 650 feet, when possible, the two rails are bonded to water mains, but when no water pipes are in the vicinity cross-bonds are placed every 350 feet.

The turnouts are about 300 feet long, which gives 100 feet of standing room. The frog angle is nine degrees and the curve of the switch on the centre line has a radius of ninety-nine feet seven and one-half inches. Spring switches are used at all turnouts. When it is impossible to use the compressor at the switches, points and frogs, then the bond terminals are hand rivetted, but in addition bridge bonds are placed and the bond compressor used on these terminals.

The Lorain Steel Company furnished the "specials" for the turnouts, the tracks at the car barn, the sharper curves and many crossings. Curves with a radius of 1,000 feet and over are sprung in during track laying, but curves with less radii are bent on a hydraulic rail-bender, manufactured by the Joshua Hendy Machine Works, San Francisco, Cal. The gauge of the track is four feet.

The power-house, car barn and offices, which are located at Alapai and Young streets, occupy one building, the same being constructed of brick and iron.

The power plant consists of three 260-horse-power Babcock & Wilcox boilers, three 340-horse-power Hamilton-Corliss tandem-compound condensing engines (100 revolutions per minute), a Goubert feed-water heater, a Wheeler surface condenser, air and circulating pump, Green's economizer, 144 tubes, snow-feed pump, Stratton separator and receiver and hot well. Each boiler has 108 four-inch tubes, eighteen feet long and is twelve feet wide and nine feet high, and carries a pressure of 160 pounds.

The electric plant consists of three 300-kilowatt, 500-volt Westinghouse generators, direct-connected, direct current, ten-pole (100 revolutions per minute), and ten-panel switchboard.

COMPRESSING BOND TERMINALS, HONOLULU RAPID TRANSIT AND LAND COMPANY.

The rolling stock consists of ten 10-bench cars, single trucks; fifteen 8-bench cars, single trucks; two closed cars, double trucks; eight convertible cars, double trucks, and ten trailers.

The single trucks are Brills 21E, and the double trucks are Brills Eureka maximum traction. The electrical equipment on each car is composed of two (No. 49) 35-horse-power motors, controllers, etc.

For the line work, wooden poles thirty feet long are used and are placed about 100 feet apart. The necessary span wires are so placed to allow the trolley wire, which is 4/0 copper wire, to be about twenty feet above the track. About one and one-half miles of the lines have bracket construction. The necessary feeder cables have a carrying capacity of 4/0 copper wire.

Honolulu is quite a cosmopolitan city, as is evidenced by the different nationalities employed in the construction of the road, namely, whites, Portugese, Norwegians, Germans, Japanese, Hawaiians, negroes and South Sea Islanders. It was necessary to teach practically all of this labor the various parts of the construction of an electric line.

The rate of fare charged by the Honolulu Rapid Transit and Land Company is five cents, except for children going to and from school the rate is two and one-half cents.

From the first day that it began operations it has paid running expenses, all interest on bonds, and left a surplus over.

The resident population of Honolulu is somewhat over 40,000—sailors, soldiers, tourists and travelers probably increase this number to 45,000.

That the business of the rapid transit is not merely due to curiosity is shown by the following table of weekly receipts:

RECEIPTS FROM FARES.

Week Ending			
September	7,	1901	$2,682.25
"	14,	"	2,018.65
"	21,	"	2,357.40
"	28,	"	2,200.65
October	5,	"	2,166.50
"	12,	"	2,079.65
"	19,	"	2,145.60
"	26,	"	2,149.50
November	2,	"	2,262.20
"	9,	"	2,170.40
"	16,	"	2,109.90
"	23,	"	2,412.15*
"	30,	"	3,019.10
December	7,	"	2,696.05
"	14,	"	2,782.90
"	21,	"	3,155.75
"	28,	"	3,010.10

* Part of the Kalihi Extension opened.

The actual receipts from fares for the first four months, ending December 31, 1901, have been $42,899.85.

During more than half this term only six cars were in operation. On December 31 there were ten, and now fifteen cars are used in the service.

REAMING HOLES FOR BONDING, HONOLULU RAPID TRANSIT AND LAND COMPANY.

EXPENSES.

Coal costs $8.50 a ton, delivered.

Motormen and conductors are paid thirty cents an hour.

Operating hours are from 5.35 A. M.

to 12 P. M. The men are on in two watches of nine hours each, so arranged as to give each man an hour off for each meal. A clubroom for the men is fitted up at the company's office building.

The operating and maintenance expenses during the first four months have amounted to $24,290.20, leaving a balance of $18,609.65, or at the rate of nearly $56,000 per annum. This makes a showing of operating and maintenance expenses nearly fifty-seven per cent of the total receipts.

The first chief engineer of the company was Mr. F. J. Amweg, who made the plans and superintended the construction of the power-house, car barn and office building, the installation of machinery, and the first construction of track was done under this régime. Mr. Amweg resigned May, 1901, and was succeeded by Mr. J. B. Rohrer, under whose direction all surveys and track work have been done.

National Electric Light Association.

The provisions made at the last convention of the National Electric Light Association are meeting with a favor which was not anticipated by the most sanguine promoters of the plan. Since the convention at Cincinnati there has been a total of ninety-four new members added to the roll. The latest additions are as follows:

Albion, N. Y.—Albion Steam Power Co.

Attleboro, Mass.—Attleboro Steam and Electric Co.

Athens, Ga.—Athens Electric Railway Co.

Beverly, Mass.—Beverly Gas and Electric Co.

Brookline, Mass.—Brookline Gas and Electric Co.

Carbondale, Pa.—Lackawanna Valley Electric Light and Power Supply.

Cohasset, Mass.—Cohasset Electric Co.

Duluth, Minn.—Duluth General Electric Co.

Doyleston, Pa.—Doyleston Electric Co.

Elwood, Ind.—Elwood Electric Light Co.

Everett, Wash.—Everett Railway and Electric Co.

Lee, Mass.—Lee Electric Co.

Lynn, Mass.—Lynn Gas and Electric Co.

Oneonta, N. Y.—Oneonta Light and Power Co.

Oil City, Pa.—Citizens' Light and Power Co.

Southern Pines, N. C.—Biscoe Electric Light Plant.

Telluride, Col.—Telluride Electric Light and Power Co.

Walla Walla, Wash.—Walla Walla Gas and Electric Co.

Warren, Ohio—Warren Electric Light and Power Co.

Westboro, Mass.—Westboro Gas and Electric Co.

Whitman, Mass.—Whitman Light and Power Co.

THE DESIGNING OF TELEPHONE APPARATUS—IV.

BY W. A. TAYLOR.

An important consideration is the diaphragm, as to its diameter, thickness and distance from the pole-pieces. The diaphragms that are usually made are about two and one-eighth inches in diameter to two and one-quarter inches in diameter, with an available vibrating portion from one and seven-eighths to two inches. The thickness is usually about one one-hundredth of an inch. The distance from the pole-pieces varies widely in different makes—from one-thirty-second down to one-sixty-fourth of an inch. A good rule to go by is to make the distance as close as possible and still not have the diaphragm touch the pole-pieces. At the greatest amplitude of vibration this distance should be about one-sixty-fourth of an inch, with a diaphragm of the above dimensions.

In the receiver the diaphragm does not need damping springs, as the magnet exercises sufficient damping effect; any other pressure brought to bear does not assist in the results. Should the diaphragm be made larger in diameter, the thickness should also be increased. The matter of dimensions is determined by testing a large number, choosing the best. It is well to keep the diameter of the diaphragm as small as possible.

The winding of a receiver should be placed just as near the end of the pole-pieces as possible, so that any changes in the current may produce a maximum change in the field as near as possible to the diaphragm. Of course, the size of the spools must be large enough to accommodate enough wire to produce proper results. It is not so much the resistance which is needed in the receiver, but the number of turns. If it were possible to get the turns without the resistance it would be better. A winding space of three-eighths of an inch will allow 1,000 turns of No. 36 silk-covered magnet wire to be wound with a depth of one-eighth inch. That will make 2,000 turns to the receiver and amount to about 100 ohms. Some makers are making a receiver with but sixty ohms resistance with considerably less number of turns and are getting very good results. Other firms have placed receivers upon the market wound to 150 ohms, but it is doubtful whether anything is gained thereby. The wire must, of necessity, be much finer and consequently more apt to fail in case a static charge of electricity jumps from the winding of the core. It is always a good rule to use as coarse wire as possible for the winding, as there is less danger of a burn-out. That means wind the receiver as low as possible without sacrificing its efficiency.

This question has been often put to the writer: "Why is it that a receiver will work better with a permanent magnet than with a simple electromagnet?" The reason is due to the law that the tractive effort of a magnet is proportionate to the square of the intensity of magnetization. Suppose a receiver be excited by a current which would produce an intensity of magnetization of 5, there being no permanent magnet. Now, if a permanent magnet were used with an intensity of magnetization of 500, then the same current, acting upon this receiver, would make an intensity of 1,005 lines. In the first case the pull on the diaphragm would be proportional to 5^2, or 25. In the second case the pull due to the permanent magnet would be proportional to 500^2, or 250,000; and with the current flowing 505^2, or 255,025, the difference. We thus have a variation of the force in the first case of $25 - 0 = 25$ and in the second case of $255{,}025 - 250{,}000 = 5{,}025$. This difference is, of course, reduced considerably in an actual case on account of the permanent magnet being of much less permeability than a soft iron electromagnet core. The difference is, however, very greatly in favor of the permanent magnet. It might be thought that if the magnet became stronger and stronger the receiver would increase in loudness, but there is a limit which is reached when the diaphragm becomes saturated, in which case there is a very small change in the pull for a large variation in the magnetism.

The inside parts of the receiver should be supported as nearly as possible to the diaphragm end of the shell, otherwise in cold weather the shell will contract till the diaphragm touches the pole-pieces. The material from which most shells are made has a very high coefficient of expansion; much higher than metal, and that is the reason for the trouble.

No doubt pure hard rubber makes the finest appearance, but is almost prohibitive on account of its cost, especially so since competition has become so very close. For a long time no good substitute was found, but recently several good compositions in imitations of the hard rubber have been introduced and are giving first-class service.

WATCH-CASE RECEIVERS.

This class of receivers differs in shape from the previously described type and,

with the exception of the magnets, are dimensioned much the same. It is more difficult to make this class of receivers properly on account of the small space allowed and also because of the weight being limited. These receivers are used as operators' head receivers, and, on that account, must be made as light as is consistent with good construction. Because of the short magnetic field in these receivers, they are more easily demagnetized, therefore more care is exercised in their making. The magnets are, in nearly all cases, of the compound type; that is, several thin magnets built up one upon the other with like poles in contact with each other. There are usually four of these permanent magnets and the pole-pieces are generally clamped between them, two magnets above and two below.

The magnets are punched from sheet metal and are of two kinds, the circular, as shown in Fig. 6, and the horse-shoe, as shown in Fig. 7. Of the two types the writer has found that the one shown in Fig. 7 is the better, as it retains the magnetism better. The poles of this magnet may all easily be made to come at the ends of the magnet, as shown by the letters N and S. The magnetic circuit is much longer, as it includes an arc of 300 degrees. It is also much easier to arrange the binding-post, there being plenty of room between the poles. It is a difficult matter to magnetize a ring magnet so that the poles, N and S (Fig. 6), come one directly over the other. On the first magnet the poles may be at N and S, in the second at N′ and S′, in the third at N″ and S″, and in the fourth at N‴ and S‴. It will be seen that such a condition would weaken the field of force very much. Then the length of the field is but 180 degrees.

A simple way to test the sensitiveness or strength of a receiver is as follows:

Remove the cap and diaphragm from any receiver and fasten it solidly into the tool post of a lathe. Then between the centres place a gear-wheel such as is generally used about a lathe, say about six inches in diameter. Bring the receiver poles close up to the teeth of the gear and then start the lathe on high speed. From the receiver run a line to the receiver to be tested. Upon listening to this latter receiver a loud musical hum will be heard. Now run the tool post back from the gear until a point is reached when the hum becomes inaudible. Now change the receiver, which is to be tested for another, and see if the hum can be heard with the tool post as far or farther away than before. If the tool post screw has an index attachment it will facilitate the marking of the distances. This method will not give the proportional relation between receivers, as the field of magnetism reduces more nearly proportional to the square of the distance between the pole-pieces and the gear teeth. This is, however, a simple test for loudness and sensitiveness, but will tell absolutely nothing about articulation. The latter is, of course, of the most importance and can be judged only from a test of words given from a transmitter known to be very superior. Most any receiver will articulate plainly on a line where the voice impulse is weak, but the severe test comes from transmission which is excessively strong.

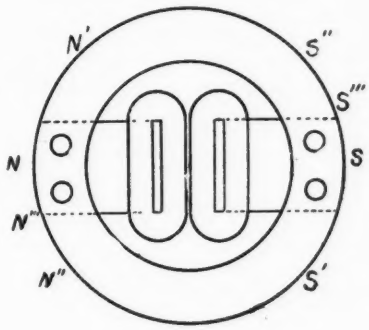


FIG. 6.

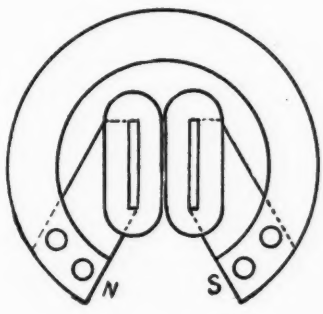


FIG. 7.

Telegraphers Form a Union.

The first organization of telegraph operators into a union was consummated in Chicago, Ill., on September 21. The organization is to be known as the International Union of Commercial Telegraphers, and was formed by a convention of forty delegates, representing as many cities. The convention elected officers as follows: President, I. J. McDonald, Chicago; first vice-president, M. J. Reedy, Boston.

Electrolysis and Its Remedies.

In a paper read before the recent convention in New York city of the International Association of Fire Engineers, Captain William Brophy made the following suggestions as to electrolysis and its effects:

"The better plan would be to break the continuity of the metal in the pipes by inserting insulating joints therein at suitable points, thus preventing any flow of current over them. In that case the poorly bonded track would have to receive immediate attention and its carrying capacity increased either by proper bonding, increasing the size of the rails, or the addition of return feeders. If neither plan was adopted an increased coal bill would be the result.

"This plan of placing insulators, or circuit-breakers, was not adopted at first because none had been devised. But within a quite recent period such circuit-breakers have been devised, manufactured and used.

"In one of our large cities a natural gas system of piping had been connected by a large cable to the dynamos of the street railway system in order to drain them of current, but electrolytic corrosion took place very rapidly at the joints. In this case "necessity was the mother of invention," and an insulating joint was devised and inserted at suitable points in the pipe system, and the connection to the dynamo discontinued, since which time no corrosion of the pipes has taken place.

"I have quite recently taken measurements between the natural gas pipes and the rails of the street railway in Wheeling, W. Va., to ascertain the flow of current from pipes to rails, also to ascertain the flow of current in the different lines of pipes. I will not give here a list of these measurements, but as a result of one made near the power-house, I found 300 amperes flowing from pipe to rail, the pressure being ten volts, or representing a little over three horse-power. The gas company has decided to place insulating joints in its pipe system. I have just returned from Wheeling where the work has progressed far enough to show that the lines wherein these joints have been placed have little or no current flowing over them, and when the work is completed these pipes will not act as return feeders for the railroad, and electrolytic corrosion will cease. It will be a matter of indifference to the owners of these pipes what the condition of the street railway tracks may be."

THE CONSTRUCTION OF TELEPHONE EXCHANGES—XLII.

BY A. E. DOBBS.

SOME OTHER BRIDGE TESTS.

We have now seen that the ordinary bridge set can be made to measure:

First—Any unknown resistance from 0.001 to 10,000,000, or more ohms, and that inversion of resistance indicates conductivity.

Second—It can be used in connection with an outside battery and galvanometer should its own battery not be strong enough, or its own galvanometer not sensitive enough. Its own rheostat can also be used to obtain its own galvanometer constant when necessary for direct-deflection measurements.

Third—Where a too great sensibility is not required it can be used for direct-deflection measurements and with battery enough, as already shown, it becomes possible to measure insulation up to over 2,000 megohms.

Fourth—May be used to locate crosses or short-circuits by direct measurements when the resistance per unit length of line is known.

Fifth—May be used to locate crosses or grounds by either the Varley or Murray loop methods without regard to the resistance of the ground contact.

Sixth—May be used as an ordinary resistance box by plugging out the ratio arms and using the R arm as a rheostat. This is accomplished by unplugging one of the ratio arms, disconnecting it from the bridge altogether, and either connecting the other arm to the rheostat, thus adding its resistance to that of the rheostat, or by plugging out its coils use the R arm only, connecting the apparatus to be tested to the outside, or X, binding-posts. This will give a resistance of 11,000 or more ohms and might be useful in finding the electrical distance of a magneto bell or relay.

Seventh—May be used to check an ammeter or voltmeter, measure the internal or external resistance and electromotive force of batteries, or measure an unknown voltage in terms of known electromotive force. With these functions of the set, however, telephone men have little to do and we will not discuss them further.

Eighth—There is, however, one more function of the portable test set that may occasionally be of service to telephone men and that is the measuring of self-induction of coils, relays or even lines.

When an impulse is sent over a line, there are two disturbing forces differing somewhat from each other, but both having a tendency, though in opposite directions, toward flattening out the wave-form and both having an influence on neighboring circuits.

These disturbing currents are known as electrostatic and electromagnetic or self-induction. They are also sometimes referred to as leading and lagging currents from their position in relation to the impressed wave-form. The inductive effects of these currents are increased with the

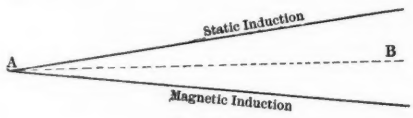


FIG. 180.

velocity of transmission frequencies, for with low frequencies used in telegraphing by the Morse system the disturbances make no sensible impression on the sending till several hundred miles of line have intervened. With telephone frequencies of several hundred, or even a thousand, per second, disturbances are noticed within a short distance unless neutralized by transposition which, however, makes static capacity none the less, while in wireless telegraphy we turn static induction to account by sending waves with a frequency of several millions per second during which the static induction becomes so great that it will not be confined to any conductor, and goes off into space to make an impression upon any apparatus fitted

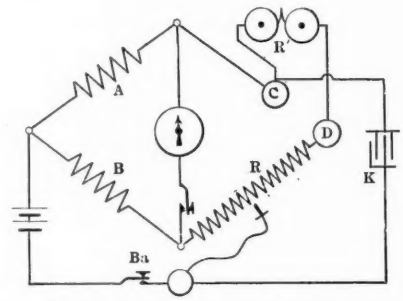


FIG. 181.—MEASUREMENT OF SELF-INDUCTION.

to receive it within several hundred miles at least.

Static induction being a leading current always opposes the induction of an electrical impulse upon a line. We might illustrate this by supposing that the line, as well as all neighboring lines, have come to a state of electrical rest, or balance, in the same manner that the water in front of a swiftly moving boat is in a state of equilibrium, or rest, until pushed aside by the boat and that any change is resisted by the water, the resistance increasing in proportion to the speed of the boat, while the waves, caused by the boat pushing the water out of the way, spread on all sides and disturbs the balance of all the water in the immediate vicinity, just as static induction spreads into all surrounding conductors, including the earth.

The lagging induction, on the other hand, does not oppose the introduction of current into the line, but has a retarding effect after the impulse has passed, as in the case of our boat there is a wash of water following the wake of the boat and tending to retard its motion by holding it back.

Like static induction, however, magnetic induction increases with the length of the line and the two might be represented as in Fig. 180, in which the dotted line AB represents a length of line, the current impulse being supposed to start from A, and the diverging lines to show the relation between static and self-induction. It of course does not follow that the two lines at any one point of the circuit will be equal, for it must be explained that though static capacity is the same for all conductors magnetic induction varies with the nature of the conductor, there being a wide difference between copper and iron wire in this respect, and it is conceivable that by a proper combination of copper and iron it might be possible to balance the two so that one form of induction would balance the other and thus secure freedom from all disturbances without the use of Pupin's load coils.

The difference between the two can be compared in other ways. As an example, in testing a cable with a cell of battery and telephone with all the conductors open, if contact is made with one of them without first sending the battery into the cable conductor there will be a click heard in the telephone, in some cases as loud as though the conductor was closed at the outer end, but by closing the contact three or four times in succession the sound disappears and silence is obtained.

This is static induction.

On the other hand, take a spark or induction coil in a closed circuit and upon breaking the contact a spark follows the opening of the key, as well known. We have another illustration in the bridged ringer which may be wound to a resistance of only 500 ohms, yet, if there are a large number of turns and the core is large enough, the voice currents will practically all remain upon the line, the leakage being small, though a non-inductive ringer would almost create a short-circuit.

The practical unit of static capacity

(K) is the microfarad, while that of self-induction (L) is called the henry.

Both the farad and the henry represent impressed currents, the former being the charge impressed upon a condenser to the extent of one volt by one ampere in one second of time. As, however, it takes a great many volts carrying one ampere to impress one volt upon a well-insulated condenser, the microfarad (1 microfarad = 0.000001 of a farad) has become the practical unit as a standard cable, for example, must be guaranteed not to have a greater average capacity than 0.08 microfarad per mile, while a well-insulated line should not exceed 0.015 for the same distance.

Like the farad, the henry represents the induction in a circuit when the electromotive force introduced equals one volt, the inducing current being varied at one ampere per second.

Unlike the farad, however, this lagging current is generally great enough not to be so finely subdivided as the farad, as an induction coil or ringer might have a lagging current of several henries.

Telephone men should know the capacity of their circuits as well as the leakage, as it will enable them to deal with many of their problems in a much more intelligent manner than they now do.

Tests for capacity are best made with a rather sensitive ballistic galvanometer in which a bridge plays no part, but the bridge can be used to measure self-induction, which we will now proceed to describe.

In Fig. 181 we have the current passing through the galvanometer in two different directions, and both dependent upon the discharge upon the breaking of the keys. From C to the junction AB we have a battery connected to a movable plug and a condenser K. On the opposite side of the galvanometer we have the ringer coils R′ in series with the rheostat R, and the arms AB. The ratio arms being on even bridge, though not necessarily so, the ringer or other coil under test is, with the help of the rheostat, balanced against the condenser K and the result calculated with the help of a rather empirical formula, $L = K \times (R + R')^2$; in which L is the self-induction, K the capacity of the condenser, which must be exactly known, R the rheostat unplugged, and R′ the resistance of the coil under test.

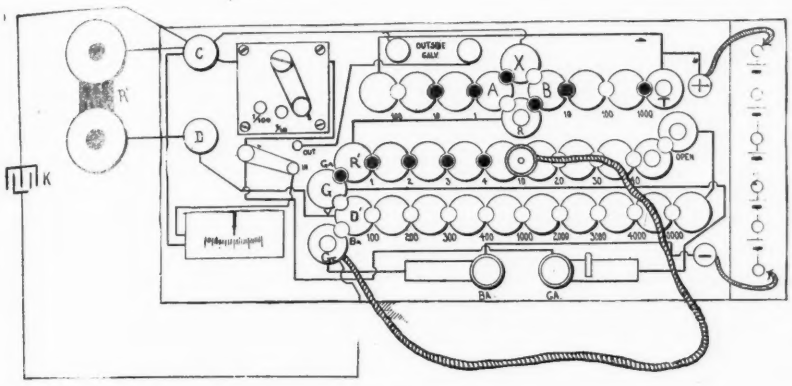


Fig. 182.

The first step is to measure the coil in the usual way to obtain the constant R′, while the known capacity of the condenser gives us the constant K. The connections are now made as in Fig. 182, and the traveling plug connected to Gr placed in one of the coils and manipulated till a balance is obtained, the other plugs also being used to help the traveling plug. A balance is obtained by pressing down both battery and galvanometer keys, leaving them closed long enough to saturate the condenser and breaking the battery key first in order to note the deflection, which will be but a single impulse, either to the right or left, till a balance is obtained.

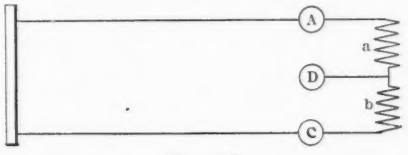


Fig. 183.

We now apply our formula as above.

Example: A coil has a resistance of 1,213 ohms, and upon being balanced against a 1.5-microfarad condenser reaches zero balance at 2,917 ohms in the rheostat. What is the self-induction of the coil in henries?

Solution: Formula $L = K (R + R')^2 = (2{,}917 + 1{,}213)^2 \times 0.0000015 = 25.58$ henries—*Answer.*

Note: Do not forget that the microfarad is the decimal part of a farad.

The condenser may be of any known value, but it is important that its capacity should be exactly known.

A coil whose inductance is exactly known may be used in place of the condenser, if desired, as is done in the ohmmeter shown in Fig. 183, where one coil is balanced against the other and the result compared in percentage of the length of the scale, *b* being the known and *a* the unknown coil.

A Human Electric Battery (?)

From time to time stories appear in the daily press of electrical freaks which are astounding in the capacity which they exhibit for giving off charges which must indeed be uncomfortable auxiliaries to daily living. The following is a clipping from a Chicago contemporary: "Anybody who shakes hands with Henry Longman, of Summerville, Pa., gets an electric shock of confusing power. Three years ago, while peeling tanbark, he was struck by lightning and has ever since possessed the queer power of transmitting an electric shock to everything he touches, writes a reporter for the Detroit *News-Tribune*. By passing a blade of a knife between his thumb and finger during progress of a storm he charges the metal so strongly that heavy weights can be lifted. When flies alight upon him they drop dead, and when he is in a dark room his eyes shine like incandescent lights. Whenever a storm approaches Longman becomes so strongly charged with electricity that it is dangerous to touch him. He says he feels no inconvenience except that he dare not go near a moving locomotive for fear of being drawn against it and killed." Whew!

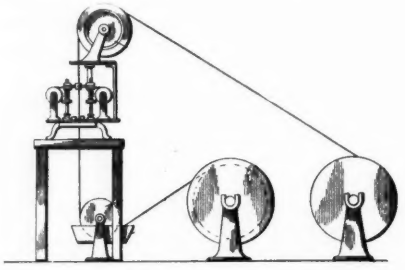
Rules for Wireless Systems.

News from Berlin states that Germany is initiating an international conference, to be held in October, on wireless telegraphy, holding that as the practical working of the system is assured it should be subject to rules similar to those of the international telegraph conventions.

The latest issue of the "Four-Track Series," published by the general passenger agent of the New York Central & Hudson River Railroad Company, is one that will be appreciated by every student in the country. It is entitled "Historical Pilgrimages About New York and Along the Hudson River," and describes a large number of delightful journeys that might be taken with great profit by teacher and student alike.

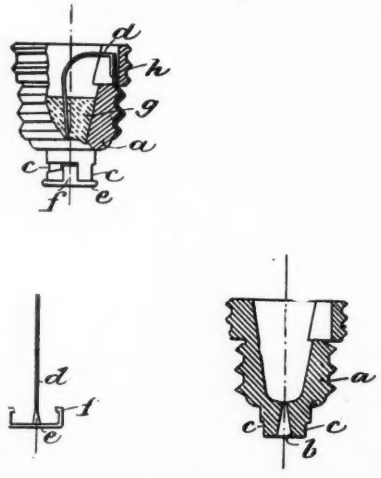
Electrical Patents

An extract from a recent patent granted to Louis W. Downes, of Providence, R. I., for a process of manufacturing electrical conductors, explains the invention as follows: "The rapid introduction and use on a large scale of asbestos insulated wire have heretofore been prevented by difficulties, first, in producing a fine yarn of this material; second, in reducing the thickness of the insulation on the wire to such an extent as to enable it to replace the cotton insulated wire now in use. It must be understood that the spacings allowed for insulation in any electrical apparatus are of necessity limited and can not easily exceed certain reasonable proportions. Any attempt, therefore, to replace existing insulating material would be extremely difficult unless the new insulating material employed possessed the same general dimensions as the old, as any attempt to discard existing designs and dimensions would unquestionably fail. Investigators have for many years been seeking a process by which the thickness of the insulation, where asbestos was employed, could be brought down to reasonable limits. While the inventions of my previous patents relating to processes and machines adapted particularly for coating metallic conductors with asbestos insulation have been quite successful in accomplishing these results, extensive experiment and investigation have disclosed difficulties which have at least tended to retard the industrial extension of the use of the asbestos insulated conductors produced according to said inventions. These difficulties consist in the injury done occasionally to the asbestos insulation in the carding and rolling thereof, particularly in the rolling, as the rolls quite frequently become clogged and, catching the asbestos yarn, tear it off the wire. This necessitates stopping the machinery and a material loss of time in repairing the damaged portion of the insulation. This difficulty is largely due to the fact that the rolls, in order to make contact with the periphery of the covered wire, must be of extremely small diameter, it being necessary to employ three rolls bearing on the wire in practically peripheral alignment in order to hold the wire centrally and act uniformly on the asbestos covering. After extensive experiments I have succeeded in avoiding the difficulties above referred to by my present invention, the principal feature of which consists in subjecting the asbestos insulation to pressure alternately applied and released. This pressure is preferably applied in the form of a rapid succession of blows uniformly distributed over the entire surface of the insulation and acting to beat down and compress the same against the wire; or, in other words, the asbestos insulation is swaged or subjected to a swaging operation analogous to that employed in the working of metals. The compressing force being alternately exerted and released, there is little, if any, danger of the parts of the mechanism catching and tearing off the asbestos covering. At the same time the covering is compressed, compacted, or felted together to a remarkable degree, it being thus possible to reduce the dimensions of asbestos insulated conductors to an equality with the dimensions of ordinary magnet wire insulated, for example, with cotton. I am thus enabled to produce a product of practically uniform diameter throughout, greatly improving in this respect upon asbestos insulated conductors produced heretofore."



PROCESS OF MANUFACTURING ELECTRICAL CONDUCTORS.

The last issue of the Patent Office discloses an important development in lead

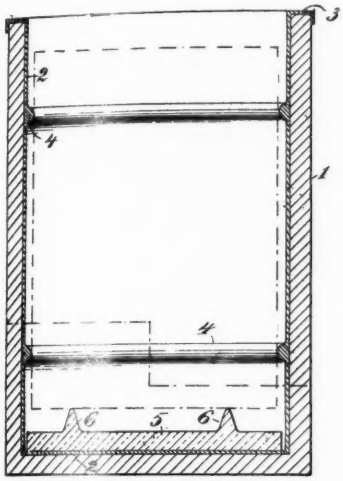


LEAD FUSE FOR ELECTRICAL CIRCUITS.

fuses for electric circuits, the object of the invention being to do away with the metal lining, and to so construct the fuse plugs that they can be easily repaired when the wire is melted through. The fuse plug consists of a hollow body, *a*, of china or other suitable insulating material, the upper part of which resembles the fuse plugs now in use. The body has a conical opening, *b*, in its lower end, and the body is provided at its outside with two slots or grooves, *c*. A contact plate, *e*, is employed, to which the wire, *d*, of lead or other fusible metal is connected, and this contact plate has oppositely arranged arms or wings provided with hooks, *f*. The grooves, *c*, of the body of the plug are adapted to be engaged by the hooks, *f*, and form with said hooks a bayonet joint to fasten the contact plate, *e*, to the body when the plate is turned. The grooves, *c*, have an inclined surface and the upper part of the incline may be provided with depressions, which receive the hooks and hold the contact plate, *e*, in position. A ring can be arranged around the lower part of the device to press the hooks of the contact plates into the grooves. The hole, *b*, through the bottom of the body, *a*, is made conical in order to facilitate the insertion of the wire, *d*, and to readily receive the lower end of the wire, which, at its junction with the plate, *e*, is somewhat enlarged. The diameter of the opening, *b*, at the top is just sufficient to permit the wire employed to pass through. This serves to prevent the gypsum, *g*, moulded into the plug, from passing through the hole, and also prevents the employment of a wire too thick to give the desired result. The upper end of the wire, *d*, can be fastened to the ordinary copper contact, *h*, by soldering or in any other convenient manner, after which, as already mentioned, gypsum can be moulded into the device in the usual manner. The repairing of a fuse plug, the wire of which is burned through, is very easily performed in the following manner: First, the fuse plug is pressed against a revolving conical cutting file in order to loosen the gypsum, and the dust is brushed out by means of a metal brush. A new contact plate, *e*, with a fusible wire, *d*, is then placed in position, as above described, the end of the wire is fastened to the contact, *h*, gypsum is moulded in the plug, and the device is ready for use. Mr. Frederick H. Krebs, of Copenhagen, Denmark, is the patentee of this new fuse plug.

Patent No. 709,157, dated September 16, 1902, and granted to Patrick Kennedy, of Brooklyn, N. Y., covers a new design in storage battery jars, particularly when used in installations for the lighting of railway cars. In order that the present invention may be understood it will be convenient to explain that in practice the jolts and shocks incident to the operation

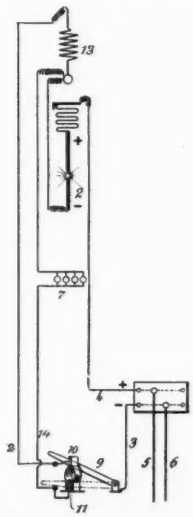
of railway cars render it necessary in constructing jars for storage batteries for such use to provide cushioning devices of soft, yielding material, such as soft vulcanized rubber, which will resist acids and protect the plates as well as protect the lining of the jar from injury by the plates. In the illustration, 1 represents the outer or main receptacle, which will ordinarily be of wood. This outer receptacle has in it a closely fitting and integrally formed lining, 2, of soft vul-



New Design for Storage Battery Jars.

canized rubber. This lining being thoroughly flexible will be moulded and vulcanized separately and then fitted into the box or receptacle, 1. The lining or inner covering, 2, will have a top flange, 3, which takes over and encloses the upper edge of the wooden receptacle, and one or more bead-like projecting guards, 4, extending about its inner surface, two being preferred. These guards will be or may be integral with the lining, 2, and they serve as buffers to keep the plates or elements from contact with the lining at the sides of the receptacle. In the bottom of the receptacle and resting on the rubber lining is a plate, 5, preferably of ceramic material and glazed. This plate may be removable and has on its upper surface two or more ribs, 6, upon which the plates or elements of the battery are supported. These supports serve to distribute the weight of the elements evenly over the bottom of the receptacle and also elevate them, so as to leave a space below to catch and hold any substance that may fall from the elements. The jar will withstand the jolting and shocks to which it may be subjected on the car without rupture or cracking of the lining, and the guards, 4, protect the plates or elements against injury from the same causes. The ribbed bottom plate, 5, is supported on the soft rubber lining of the bottom and is thus cushioned. This plate may, of course, be made from any hard material which will not be acted upon by acids or other substances in the battery.

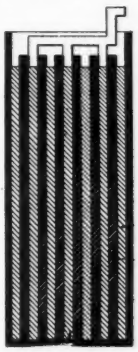
John W. Lieb, Jr., and Joseph H. Tyler, of New York city, have invented and patented an exceedingly practical electrical attachment for the common or ordinary street illuminating arc lamp, whereby the names of streets may be effectually displayed at night. The inventors make explanation of their invention as follows: "In arc lamps, especially for the lighting of city streets, steadying resistances are ordinarily interposed in the branch circuit belonging to each lamp in order to prevent fluctuations of the light. This resistance now serves no useful purpose other than already stated. In accordance with our present invention we use as the steadying resistance aforesaid electric glow lamps, and arrange said lamps preferably in a case or lantern supported on the post which carries the arc



Street Sign Illuminating Device.

lamp. Said lantern may have translucent sides with opaque characters, or opaque sides with translucent characters. As usual, the lamp post is hollow to receive the lamp circuit wires which connect to the street mains. In the lamp circuit are interposed a plurality of glow lamps, 7, arranged in multiple. Said lamps are supported in any suitable manner upon the post and are shown within the lantern, 8, the sides of which may be translucent and marked with street names. In the arrangement shown the arc lamp at the moment of establishing circuit may operate to cause a current in the glow lamps which may injure them. To avoid this, we connect the lamp circuit wire, 3, with a pivoted switch lever, 9, which is constructed to enter between two spring clips, 10, and on being carried farther down to pass from between these clips, 10, and enter between the spring clips, 11. Clips 10 and 11 are insulated from one another. Clip 10 is connected by wire, 12, to a resistance, 13, and to the terminal of the arc lamp. Clip 11 is connected by wire, 14, to the glow lamps, 7, and so to the same lamp terminal. In operation, lever 9 is first placed between clips 10, so establishing circuit through the resistance, 13, and the lamp until the arc is fully established. Then lever 9 is moved to break contact at clips 10 and establish contact at clips 11, when the resistance, 13, becomes cut out and the glow lamps, 7, are brought into the lamp circuit and act thereafter as the steadying resistance for the lamp, as already explained."

A resident of Los Angeles, Cal., Mr. Arthur W. Harrison by name, has patented a novel separator for the electrodes of storage batteries. It has been, of course, the aim to provide an article of this character which will prevent short-circuits and at the same time be very light, these features specially being desirable in automobiles. Essentially, Mr. Harrison has discovered that a plate-separator may be made from yucca, preferably *Yuccas brevifolia*, provided the starch and non-fibrous material are first extracted without destroying the fibre. To accomplish this, the tree is cut in the desired lengths and into layers of the necessary thickness. These layers are then treated by either an acid or an alkaline process to remove the starch and other non-fibrous portions. In practice it has been found that for this purpose a very convenient method is to boil the raw yucca, cut to the desired size, in a weak solution of sulphuric acid or caustic soda until the starch and other undesirable material are dissolved. It is then taken out of the liquid and dried, whereupon it is ready for use. The in-



Electrode Separator for Storage Batteries.

ventor claims that yucca prepared in the above-described manner forms a very tough and exceedingly light non-conducting electrode separator, which permits a free circulation of the fluid around the electrodes, and at the same time perfectly insulates them from each other and prevents the formation of short-circuits. If the non-fibrous material is not removed it clogs the circulation and interferes with the action of the battery. Mr. F. A. Marcher, also of Los Angeles, Cal., has purchased a two-thirds interest in the patent.

Reviews of Current Engineering and Scientific Literature.

Giving Concisely the Substance of Important Papers in the Scientific, Electrical and Engineering Press of the World.

Practical Method of Calculating Transformer Reactance.

The object of this article is to present to the non-mathematical reader a simple method for arriving at a basis from which the short-circuit reactance of transformers of ordinary commercial design may be predicted. The fundamental fact made use of is that when the secondary winding of a transformer is short-circuited and an alternating current is passed through the primary then the induced secondary ampere-turns are equal in opposition to the primary ampere-turns. The short-circuit reactance may then be considered as due to the magnetic leakage flux in the region between the primary and secondary sections. The total reactive voltage is equal to the effective cutting of the primary and secondary windings by this flux. Other things being equal, the leakage flux is proportional to the primary ampere-turns. The reactive voltage is proportional to the product of the primary ampere-turns and the number of turns in each coil. To find a suitable constant to introduce in the above relation the air-path of the magnetic flux must be considered. The reluctance of this path will be taken as inversely proportional to the cross-section of the path and its length. Combining this relation with that given above, and applying the test to various types of transformers, a constant can be found for each type which will enable the reactive electromotive force to be predetermined for any new transformer of this type. If the primary and secondary windings are not close together another term must be computed to to allow for this condition. This can be found by computing the magnetizing force and the reluctance of this space, and from this, knowing the number of turns in each coil, the correction may be made.—*Electrical Review* (London), September 5.

Reclaiming Waste Heat from Flue Gases.

The flue gases or products of combustion escaping from coal burning under a boiler at a temperature of 500 to 600 degrees Fahrenheit, carry with them from twenty to twenty-five per cent of the heat energy. There are two methods by which a very considerable part of this heat may be saved. These are described and discussed in this article by Mr. C. G. Robbins. The first and most common method is the use of the economizer. The fuel saving due to the economizer is estimated as follows: One pound of coal will evaporate on an average about nine pounds of water, and will furnish about twenty-one pounds of fuel gas. The temperature of this gas will be reduced in the economizer from about 600 degrees to 300 degrees. The specific heat of the flue gas is 0.24. In falling 300 degrees, each pound of gas gives up, therefore, seventy-two British thermal units, and the twenty-one pounds of gas will give up 1,512 heat units. This would heat the nine pounds of water which the pound of coal evaporates sixty-eight degrees if the apparatus were perfect. In practice, it is found that about 1,200 heat units can be saved. This represents about 9.4 per cent, assuming the average heat value of coal to be 13,000 British thermal units. The second method of reclaiming the waste gases is by using them to preheat the air before admitting it to the fire. Tests show that the temperature of the gases may be reduced in this way from 150 to 250 degrees, and the air is heated to a point about 140 degrees below that of the escaping gases. The twenty pounds of air required for the combustion of one pound of coal will therefore absorb 900 heat units. This represents 7.4 per cent of the heat of the coal. The author then discusses the relative advantages of the two systems, both of which require either mechanical draught or an increased height of chimney. When the plant has other means of heating, or when the water contains impurities which are deposited in the economizer, it is advisable to use the air heater. In a compound condensing plant with steam auxiliaries, or in a non-condensing plant, the feed water can be heated by the exhaust steam and the air heater would probably prove more economical, as well as simpler. In a condensing plant with power auxiliaries the economizer should be used. A rough estimate of the allowable investment of each system is then made. For a 1,000-horse-power condensing plant this is found to be $7,570 for the economizer and $5,954 for the heater. For a 600-boiler-horse-power, corresponding to the 1,000-engine-horse-power mentioned above, the investment for boiler-horse-power would be $12.33 per horse-power for economizers, allowing for attention, and $9.92 per horse-power for air heaters. Either system can be put in for much less than this.—*Engineer*, September 15.

Pressure Rise in High-Tension Transmission.

This is a non-mathematical discussion by W. H. Woodhouse on the causes and effects of sudden pressure rises in high-tension transmission. Long-distance high-tension transmission necessitates receiving apparatus possessing large impedance, and transmission lines either with considerable capacity or inductance, according as the line is an underground insulated cable or a system of overhead wires. The trouble peculiar to overhead lines is that of lightning discharge. A direct discharge will usually break down the line to earth, with a consequent short-circuit. A discharge of lightning in the neighborhood of an overhead line may be sufficient to induce a serious rise of pressure, throwing synchronous machines out of step and breaking down the insulation of the system. To prevent these effects lightning arresters are inserted at various points, usually in connection with a choking coil. The latter, however, is not thought necessary, as the inductance of the line is great enough to cause the discharge to jump the gap in the arrester to earth. Rise of pressure may occur in cables and overhead lines, due to switching on and off and change of current flowing. In switching on to a line already carrying a current the maximum rise in pressure may be twice the applied pressure. Switching off a transmission line, which carries no current, should cause no undue rise of pressure on the line; but the switching does not take place instantly, and there may occur a discharge and recharge several times before the circuit is finally broken. This is in effect the same as switching on. The switching off of a

line carrying a current will cause a sudden rise of pressure from the discharge of the line caused by its inductance. Here the effect of the inductance of the line is more or less balanced by its capacity. Since the above stresses in a high-tension system are due to the manner in which the circuit is made or broken, much attention should be paid to the selection of switch gear. Air-break switches become useless above 10,000 volts. The oil-break switch also breaks the circuit suddenly, but without a long arc. This does not stress the system unduly. The ideal switch gear should make a break in the circuit when the current wave passes through zero. In the author's opinion, the system will be fully protected if spark-gaps be fixed between the lines on both cables and overhead lines, the gaps being set to discharge at from one and one-half to twice the working pressure. In some experiments recently made, this arrangement was found to be very effective.—*Electrician* (London), September 5.

Electric and Magnetic Properties of Bodies at Low Temperatures.

In his inaugural address at the Belfast meeting of the British Association, Professor James Dewar gives a brief review of the work which has been carried on at low temperatures. Some of the results of the study of magnetic and electric properties are extremely interesting. In conjunction with Professor J. A. Fleming, a long series of experiments was made on the electric and magnetic properties of bodies at low temperatures. The subjects that have been under investigation may be classified as follows: The thermo-electric powers of pure metals, the magnetic properties of iron and steel, dielectric constants, the magnetic and electric constants of liquid oxygen and magnetic susceptibility. The investigations have shown that electric conductivity in pure metals varies almost inversely as the absolute temperature down to minus 200 degrees, but that this law is greatly affected by the presence of the most minute amount of impurity. Hence the electric resistance in pure metals is closely dependent upon the molecular or atomic motion which gives rise to temperature, and that the process by which the energy constituting what is called an electric current is dissipated essentially depends upon non-homogeneity of the structure. It might be inferred that at the zero of absolute temperature resistance would vanish. This conclusion has been rendered very doubtful by subsequent observations made at still lower temperatures, which appear to point to an ultimate finite resistance. Thus, the temperature at which copper was assumed to have no resistance was minus 223 degrees, but that metal has been cooled to minus 253 degrees without getting rid of all resistance. The reduction of resistance of some of the metals at the boiling point of hydrogen is very remarkable. Copper has only one per cent, gold and platinum three per cent and silver four per cent of the resistance possessed at zero C. Iron, however, still retains twelve per cent of its initial resistance. In the case of alloys and impure metals, cold brings about a much larger decrease in resistivity. In the case of carbon and insulating materials, the resistivity steadily increases. The enormous increase in the resistance of bismuth, when transversely magnetized and cooled, was also discovered. In magnetic work, the result of greatest value is a proof that magnetic susceptibility varies inversely as the absolute temperature. This shows that the magnetization of paramagnetic bodies is an affair of orientation of molecules, and suggests that at the absolute zero all the visible paramagnetic bodies will be strongly magnetic. The study of the thermoelectric relations of the metals at low temperatures resulted in a great extension of the well-known Tait thermo-electric diagram. Tait found that the thermoelectric power of the metals could be expressed by a lineal function of the absolute temperature, but at the extreme range of temperature under consideration this law was found not to hold generally. It further appeared that many abrupt electric changes take place, which originate probably from very specific molecular changes occurring in the metal. The thermoelectric neutral points of certain metals, such as lead and gold, which are located at or below the boiling point of hydrogen, have been found to be convenient means of defining specific temperatures in this exceptional part of the scale.—*Nature* (London), September 11.

The Kalgoorlie Electric Power and Lighting System.

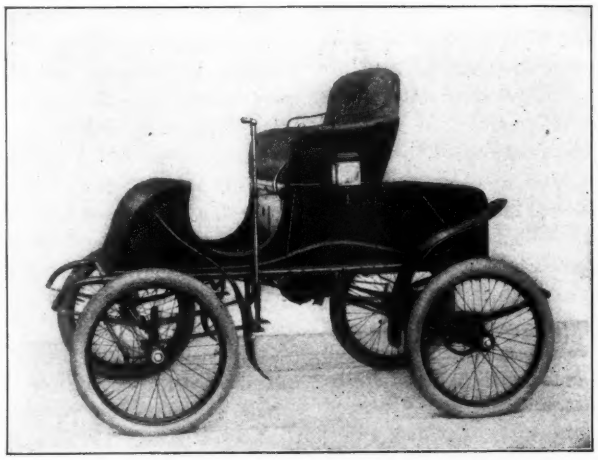
This article describes the first large power distributing system in Australia. In the neighborhood of the Kalgoorlie gold fields, within a radius of three miles of the town, over 15,000 horse-power is used for various purposes. This plant was installed to furnish the requisite power to the various industries there. The equipment consists of direct-connected generators, coupled to vertical engines furnishing alternating current at forty cycles and 550 volts. The principal interest in this article is in the description of the methods adopted for securing feed water. The average annual fall in this country is about one-half an inch, so that practically the only water obtainable is that pumped from the mines. This is limited in quantity, is very expensive and is bad. A sample of feed water showed over twenty-four per cent of total mineral matters present, and about five per cent of solid matter. When it is remembered that ordinary sea water contains only 3.4 per cent, the quality of this water will be recognized. The method adopted for purifying this consists in evaporating the water in shell boilers, which can be operated in relays, permitting daily cleaning to remove the scale. This is deposited to a thickness of several inches in that time. As ordinary condensing methods could not be used here, aerial condensers were decided upon. The condenser plant consists of three aerial condensers, each capable of condensing 16,000 pounds of steam per hour at eighty-five degrees Fahrenheit, giving a vacuum of fourteen inches. The vacuum varies with the temperature of the air, and, although not high, it is impossible to improve it in a hot climate without unjustifiable expense. The air supplied is furnished by twenty-seven fans, each seven feet in diameter, capable of delivering 2,250,000 cubic feet of air per hour. These fans are driven by nine induction motors of fifteen horse-power capacity each. The condenser itself consists of a series of chambers composed of thin corrugated metal plates, giving the maximum possible cooling surface with the minimum number of joints and connections. There are three horizontal double-acting air pumps, driven by seven and one-half horse-power induction motors. Steam is generated in water-tube boilers at a pressure of 160 pounds. The engines are of the vertical cross-compound low-speed type, with a guaranteed efficiency of fourteen pounds of water per indicated horse-power-hour. The evaporating plant consists of ten shell boilers, each five feet in diameter and twenty feet long. The steam from these is conveyed to a system of cooling drums, consisting of a corrugated iron drum, each six feet three inches in diameter and twenty-four feet long, and having a flue three feet three inches in diameter in the centre of each. The station also furnishes power to the local tramway company, having installed two 250-kilowatt, 40-cycle rotary converters for this purpose.—*Electrical Review* (London), September 12.

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Electric Automobiles.

Since the introduction of the horseless carriage, there have been many types which have been designed with the idea simply of instituting in the vehicle a motive power which shall be self-contained, and realizing this result with the minimum change from the already existing forms of horse-drawn vehicles. The gasoline and steam-propelled vehicles have advantages over the electric which are inherent from the nature of their construction. The opportunity, however, for designing a machine which will be at once easy of control, elegant in appearance and offering the most radical departure of the auto car from the horse-drawn vehicle, lies with the manufacturer of that electrically driven.



PANEL SEAT ELECTRIC RUNABOUT.

Where it is possible to combine the art of carriage making, as developed through long experience in the manufacture of the older type of conveyance, with the mechanical simplicity and orderliness which follow the installation of a storage battery driving a motor, an apparatus will be made which will embrace the essential requirements of an up-to-date, self-propelled machine, be its use for business or pleasure.

The accompanying illustration shows a type of electric vehicle which is meeting with great success, and which is the product of much thought and effort in the right direction. This represents a panel seat runabout, the wheel base of which is sixty-one inches, the wheels thirty inches in diameter, body length seventy-three inches, body width twenty-nine inches, seat width thirty-three inches, and the floor height twenty-eight and one-half inches. The weight of the vehicle complete is 1,350 pounds. The design has been made simple and easily accessible on conservative lines. In consequence, it is readily comprehended by a tyro in this branch of mechanics.

The battery with which these vehicles are regularly equipped is claimed to be the most durable produced to date. It has not the extremely high capacity of some others, the aim being made to furnish a battery which will have long life and serviceability, with the avoidance of troubles and expensive repairs. The battery consists of twenty-four cells, and is so arranged that its location is not directly over that of the motor. In this vehicle any drippings from the battery fall to the ground, and can in no way contaminate the insulation of the motor. The vehicle is equipped with one motor, and is so designed that small rises in current produce a great increase in power, and the windings are so arranged that the battery discharges are materially reduced. The motor is suspended above the spring from the running gear on which the body rests, and is so arranged that it can be swung backward or forward and fastened in position, thus securing perfect chain adjustment. This suspension of the motor above the springs not only materially relieves shocks on it and the running gear, but contributes greatly to the life of the tires, and on account of its location helps to equalize the load. The transmission is by roller chain from a countershaft built into the motor head to the balance gear on the rear axle. The pull of the chain is taken by distance rods attached to the side bars of the running gear frame and the main rear axle bearings.

The controller has four speeds, and is conveniently located on the end of the seat. The motor reverses by pressing a lever with the heel. The speeds backward are the same as forward. On each speed almost full power effect can be obtained. These speeds are equally divided, the maximum speed being thirteen miles per hour on the level road. A cutout-switch is provided, which is easily operated by the foot, to throw off the power in case of emergency. The same switch is provided with a removable handle which, when removed, makes it impossible to operate. The handle can be removed when in the "off" position and answers as a lock, preventing others from using the vehicle. The same switch when thrown into a lower position cuts out all the wire in the vehicle except between the charging plug, the switch and the battery, thus making possible any repairs to the motor, the controller or wiring while the vehicle is on charge without danger to the machine or the operator. Each vehicle is equipped with charging apparatus and a special indicating meter which reads directly the amount of energy in the battery, electric side lamps, acid-proof wiring, and original design in gears and spring. The steering apparatus is effected by a side lever, and the vehicle is fitted with a hand brake on the rear axle, operated by a foot lever working in ratchet.

The front axle is tubular, reenforced its entire length. The steering axles or spindles are made of solid steel of high carbon, forged out of one piece, and are of sufficient strength to carry the load and prevent the wheels from spreading at the bottom. The rear axle is one solid bar of steel, running from one wheel to the other, and fitted with a short sleeve

on one side to get the necessary differential effect provided with the compensating gear. The wheels are ball-bearing, and all bearings at the wearing joints have been made very large, in order to avoid wearing loss. The bodies are hung low, and are easy of ingress and egress. The batteries occupy the part in the rear of the seat, over the top of which is neatly fitted a boot, giving a finished appearance and completely protecting them, and also providing an opening so that the batteries can be properly cared for without removal from the battery compartment. The front end of each seat is removable, making access easy to the electrical parts. Perfect ventilation is provided to allow fumes to escape when discharging.

The Studebaker Brothers Manufacturing Company, South Bend, Ind., is the manufacturer of these electric vehicles. This company has been established for fifty years. At its plant at South Bend, Ind., which covers 101 acres and employs about 3,000 men, is built, besides automobiles, every known variety of horse-drawn vehicles, from a light runabout to a ten-ton truck. This long experience has placed the company in a position to solve peculiarly well the problems of suitable body dimensions, correct weight distribution, and easy spring suspension, regardless of the load carried. Hence, these points have received especial attention in the Studebaker runabout. Owing to the successful spring suspension, there is a marked absence of all sudden jolts and jars, even when riding over rough pavements.

A Portable Electric Hammer.

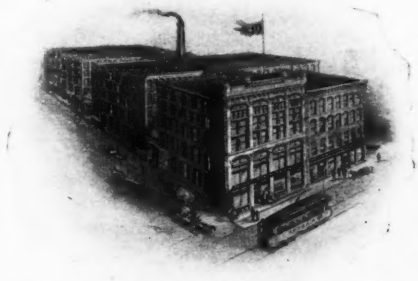
One of the most recent applications of the electric current for the manipulation of small tools is the portable hammer, which is now being placed on the market after having been thoroughly tested in every way. This hammer, the manufacturer states, can be used to advantage wherever chipping of any kind, rivetting, caulking, or stone dressing and curving is required, and is remarkable for simplicity of construction, cheapness of first cost, and cost of operation. The current necessary to operate this hammer does not involve the installation of a separate plant, as the current can be taken from any electric circuit of from 110 to 500 volts. It can be operated by a motor of from one-eighth to one-quarter horse-power, consuming practically no more current than an ordinary office fan. Where no current is obtainable, a small one-horse-power electric generator is capable of running three hammers. This may be cheaply installed, and can be driven by a small gasoline engine, turbine water-wheel, or from a shafting in the main shop or foundry. The power can be transmitted practically any distance with very little loss, and the range of service to which this tool may be applied would seem to make it a most practical and useful device. The Western

PORTABLE ELECTRIC HAMMER.

Electrical Supply Company, of St. Louis, is introducing this, the Jackson portable hammer, and claims that it is a great improvement over the ordinary form of pneumatic hammer heretofore generally used.

A Large Electrical Goods Supply House.

The general movement among hardware companies toward adding lines of electrical machinery and supplies, and the extension of the general scope of their business so as to include electrical furnishings, is well illustrated by the fact that the George Worthington Company, Cleveland, Ohio, one of the largest Ameri-



WAREHOUSE OF THE GEORGE WORTHINGTON COMPANY, CLEVELAND, OHIO.

can hardware companies, has recently established a department for all products pertaining to electric lighting, street railway and telephone work. The company has recently published a sumptuous catalogue, illustrating nearly all standard electrical articles. To a representative of this journal the statement was recently made by this company that the general demand of its patrons compelled it to take this step. We herewith show an illustration of this company's mammoth establishment, which is situated on St. Clare street, near the centre of Cleveland's greatest commercial activities.

Electrical Control for Newspaper Printing-Presses.

One of the most interesting applications of electrical operation and speed control is found in a new patented system as applied to the large newspaper printing-presses used in the production of some of the most important dailies of the country. In connection with the controlling of these large presses, the application of electricity is particularly one which will give the operator a great advantage over any system of manual control. No machine, yet devised, of this immensity, while belt-driven, is so delicately balanced as to be capable of making the small part of a revolution which becomes practicable with this new system of electrical control.

The equipment for each press consists essentially of one main driving motor, one auxiliary slow-motion motor, an automatic solenoid controller, eight push-button stations, an automatic clutch, a worm-gear and worm-wheel, a main driving gear for press shaft, a pinion for the main driving motor and all wiring and connections except those bringing power to the controller. The foundations are furnished by the purchaser in accordance with the engineer's drawings. The push-button stations are located wherever desired on the press. Each station consists of three buttons and a safe switch, and from any station the pressman can start, increase or decrease the speed, and stop the press at will by pushing the button. There are available at least thirty running speeds to the press, and it is guaranteed that the control shall be from a start of five revolutions per minute of the main driving shaft on the press through these steps, and any desired speed up to maximum, or from maximum speed down through these steps to standstill, or the press can be operated at any one of these intermediate speeds. Before the press is ready for running, it is necessary to attach to the rotary cylinders plates from which the impression is taken on a cylinder rotating adjacently, and

which is covered by a packing or blanket, which brings the paper just close enough in contact to make an even impression without punching through. The cylinder is in such position that the pressman can not at any one time have access to its whole surface. It is therefore necessary in placing the packing or blanket, and in affixing the rounded plates, that the cylinder shall make a very small part of a revolution and come to a stop, and the closer that this is regulated the greater will be the facility with which the operator can perform the functions for which he is employed. With this system the press can be brought to any position desired and absolutely stopped, an exact movement of one-eighth of an inch on the plate cylinder being possible. Another feature, which is of very great importance and of positive value in this connection, is that the pressman has the whole machine absolutely under his control by operating what is technically known as the safe switch. From his station he simply turns the safe switch to "safety," and while so turned it is impossible for any one to start the press until he has turned the safe switch to the "on" position. In this way any danger to the pressman, either through carelessness or misunderstood directions, is obviated.

When the press is brought to the desired speed for threading the paper through the cylinders the safe switch can be turned, and so long as on the safe it shall be impossible to increase the speed. The safe switch can also be used to prevent an increase above any desired speed, but it is always possible to decrease the speed or stop. It will be impossible, no matter how the pressman may handle the push-buttons, to start or stop the press with a jar or jerk.

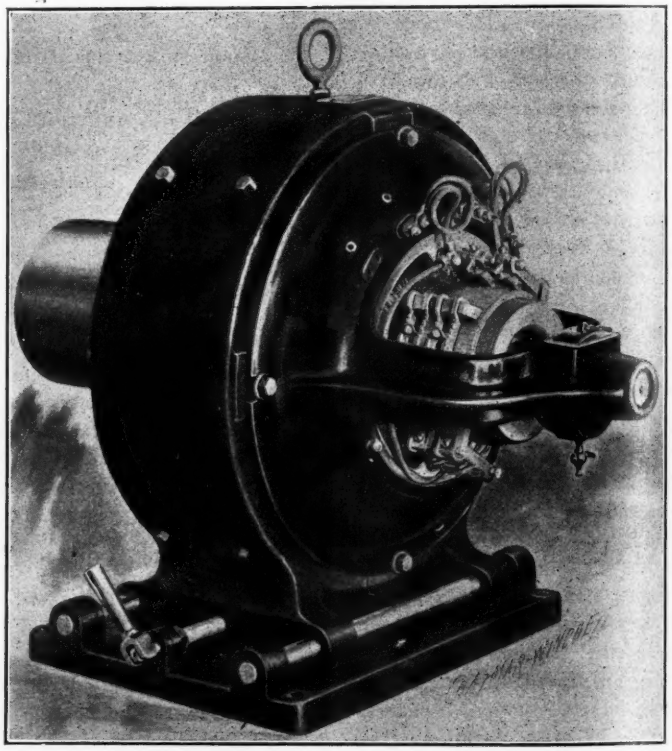
The time required to bring the press from standstill up to maximum, and from maximum back to standstill, is adjusted to suit the pressmen. The usual time is twenty seconds. The press can be instantly stopped while operating at any speed from any station. The time required to stop the press is only one-half second, necessary to prevent the stripping of gears. The gradual start makes the power required extremely low as compared with a belt-driven system. From tests made on quadruple presses manufactured by R. Hoe & Company, the Goss Printing Press Company and the Scott Printing Press Company the power required to start these presses is from three to five horse-power. The gradual increase in speed also saves power, as there are no sudden rushes of current.

Each press is equipped with an automatic device for each roll of paper on the press. If the paper should become broken the press immediately stops by this automatic device, which avoids all clogging of the paper. As soon as the paper is pasted together the press can be again started by pushing the button. By this system it is claimed that any undue load on the press, such as hot boxes, undue friction, etc., will cause the press to stop. If for any reason, whether by failure of current, mechanical accident or by design the press is stopped, the controller makes an immediate automatic return to the starting point.

These specifications are standard for this system, as patented by the Kohler Brothers, contracting electrical engineers, Fisher Building, Chicago, Ill.

Protected Type Direct-Current Dynamos and Motors.

The distinguishing features of the protected type direct-current dynamos and motors illustrated by the accompanying engravings are the circular magnetic yoke and the end-plates, which together enclose and protect all the working parts of the machine. The yoke ring is made of a special mixture of gray iron, chosen for its permeability, and cast in the foundry of the company manufacturing the machine. The ring is provided with raised seats on its inner periphery, which are machined, and to which are bolted by two screw caps the pole-pieces and cores. The pole-pieces and cores are made of sheet-steel stampings, the outline of which has been determined by exhaustive study and experiment, and it is claimed to be such as to secure an absolutely stiff field with perfect commutation under the whole range of load without shifting the brushes. The end-plates are cast in a single piece in the form of an enclosing ring or head, that on the pole end being simply provided with ventilating openings and a supporting bearing case and oil-well, while the plate on the commutator end is cast with a ribbed arm to carry the bearing case and oil-well out beyond the commutator. These plates are provided with four lugs at their outer periphery, which are machined and fitted into corresponding lugs on the yoke ring, thus being supported and centered. Each end-plate is held in position by four cap screws, the removal of which permits access to the field coils or armature when necessary. These three parts—the yoke ring and the two end-plates—when bolted together form an enclosing case which thoroughly protects the field coils and armature from injury, and at the same time allows them sufficient ventilation.

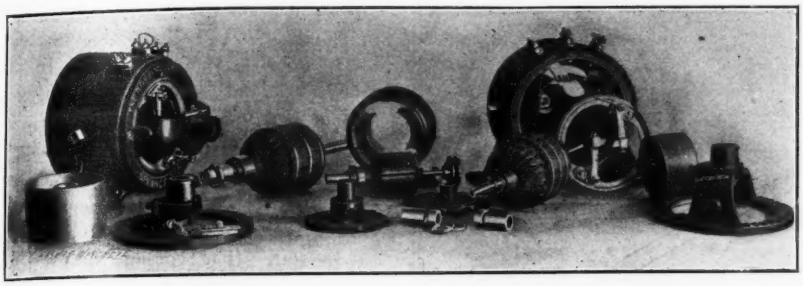


Seven and One-Half Horse-Power Protected Type Direct-Current Motor.

The shafts are made of the best ma-

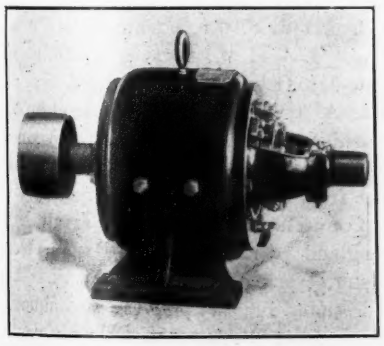
chinery steel available, and are so designed as to be of uniform strength throughout. A feature peculiar to these machines in the multipolar sizes is that the shafts may be removed from the armatures without disturbing either the windings or the commutator in case it becomes necessary to replace the shaft when worn out in service or injured by accident.

The armature cores are built up of thin discs from specially reannealed iron, made to specifications for this particular use. The slots are all cut at one stroke, making accurate work. Each disc, before assembling, is insulated with a core varnish of high insulating efficiency. The assembled core discs are clamped and held together by cast-iron flanges, which, in the multipolar sizes, also form cylindrical extensions for the support of the windings.



THE EIGHTH, ONE-QUARTER, AND ONE-HALF HORSE-POWER PROTECTED TYPE MOTORS, DISASSEMBLED.

The commutator projects between the front bearing arms in such manner as to be protected, and yet leave it and the brush-holders in full view for inspection, cleaning and adjustment. It is built up from straight copper segments cut from a hard drawn bar, separated by pure mica plates, and forced into a solid mass by hydraulic pressure. The commutator is then locked upon a sleeve having a flange at one end and a close-fitting collar at the other. The collar is drawn down by means of a number of screws which give an even pressure on the end of every bar, thus ensuring a solid commutator. The heads of the screws are let in flush with the face of the collar, and are accessible for tightening the commutator while the armature is in the machine.



ONE HORSE-POWER, PROTECTED TYPE DIRECT-CURRENT MOTOR.

The brush-holders have received most careful attention, and, as a result of much study and trial, several forms have been adopted for different sizes and voltages, the principal feature of all of them, however, being the solid clamping of the carbon brush in a brass holder, and an adjustable tension spring which carries no current.

In all of the machines the brush-holders are mounted on a large iron ring, which is so fitted on the front head as to permit of the adjustment of the brushes to the point of sparklessness, after which no further attention is needed for any change of load within the capacity of the machine. The adjustment of the brushes is effected by slightly loosening the two screws holding the brush-ring in the bipolar sizes, and three cap screws in the multipolar sizes, and turning the brush-ring until the point of sparklessness is reached.

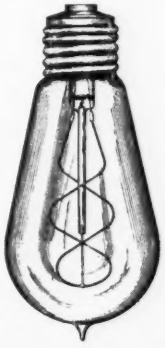
The bearings are straight sleeves of the best grade of hardened bearing metal, fitted into the bearing cases in the centre of the end-plates, and are grooved and cut away in the central portion so as to allow the passage of the oil rings. These oil rings, riding on the shaft, dip into the oil contained in large oil-wells, and provide perfect lubrication. The bearings are brought into alignment by a system of fitting the end-plates of the machine, and the bearing sleeves are adjustable in the bearing cases, by which means the end motion of the armature is controlled.

The motors, when furnished for general purposes, are plain shunt wound and give practically constant speed at all loads. When motors are intended for driving a constant load, or are to be under the control of a hand regulator, they are preferably furnished series wound. The dynamos are usually furnished with a series winding in addition to the shunt coils, which is so proportioned as to raise the voltage of the machine about five per cent above normal at full load. These machines are manufactured by the Robbins & Myers Company, Springfield, Ohio.

New Ideas in Incandescent Electric Lamp Manufacture.

In the accompanying illustration is shown a new design in the manufacture of incandescent electric lamps, the object of the inventor being to arrange the filament so as to produce a maximum and symmetrical distribution of light-rays, or, in other words, the same measurement of maximum candle-power at every point in the horizontal and vertical plane.

Referring to the illustration an ordinary incandescent bulb is used and the pendent glass mount is sealed within the top, conducting wires being connected to the carbon filament in the usual manner. The filament, however, is wound spirally, there being three convolutions. These are in fact two spirals, which are alike in form and arrangement. Thus the lower bend of the double spiral merges into the two central convolutions, and these again merge into the upper convolutions, whose terminals connect with the wire conductors. The spirals are wound in opposite directions and the convolutions are symmetrically arranged one exactly opposite another horizontally. An important characteristic of this filament arrangement is that the relative diameters of the several convolutions differ so that when seen in an end view the convolutions appear in different horizontal planes. The upper convolutions are narrower than the lower ones. The central convolutions are wider than the latter, and hence each set of opposite convolutions is so placed that it is seen from below, and therefore throws light downward, independently of the other two. In this way a maximum aggregation of light can be obtained in a downward direction. The side or lateral distribution of light is claimed also to be uniform, thus perfectly symmetrical effect is obtained.



NEW ARRANGEMENT OF THE FILAMENT OF INCANDESCENT LAMPS.

To support and steady the filament a glass anchor is employed, which depends

from the mount and is formed integrally therewith. This is provided with a wire extension which is rigidly attached to the centre of the lower bend or convolution of the filament. This anchor is also claimed to serve another important function, in that it draws to itself by static induction the carbon dust or fine particles of carbon which are given off from the filament as it grows old and which are ordinarily deposited on the bulb. This obviates the discoloring of the bulb under long-continued service.

This lamp is the invention of Mr. Glenn C. Webster, of Warren, Ohio, and has been assigned to the Sterling Electrical Manufacturing Company, of Warren, Ohio.

A New Desk Set.

The accompanying illustration shows a new desk set which represents the latest design in telephone construction. This is manufactured from the best and most substantial materials obtainable, is heavily nickeled throughout, and set upon a very heavy cast base. The upright consists of a hollow brass tube, enclosing a black fibre strip fastened to the throat of the transmitter shank. The long scraping contacts, of German silver with platinum points, are secured to the strip by a small hard rubber block, which contains one large bolt screw, whose terminal is fastened to the bottom of the fibre strip, and whose head is contained in the under side of the base. When this screw bolt is removed, the telephone may easily be

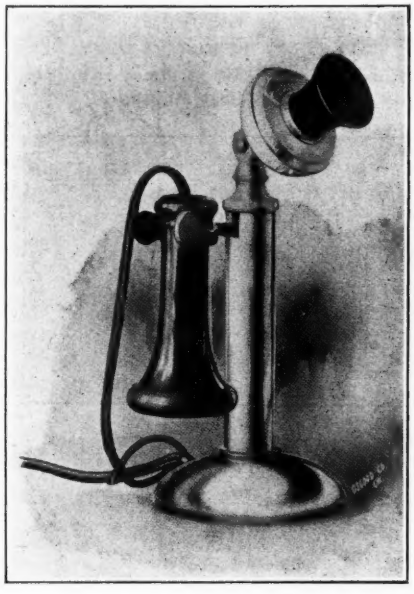


FIG. 2.—ONE OF THE NEWEST DESIGNS IN DESK TELEPHONES.

dismantled, thus making all parts accessible for repairs. Fig. 1 shows the telephone outfit dismantled. Fig. 2 shows the desk set ready for use. Should the instrument

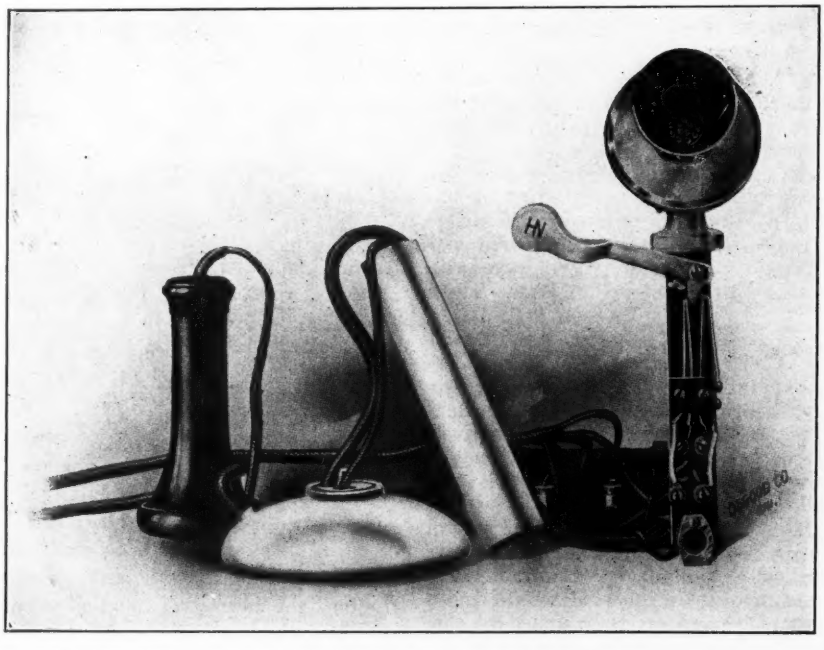


FIG. 1.—A NEW DESK SET, SHOWING ESSENTIAL FEATURES OF CONSTRUCTION.

also the hook with the spring. The hook is screwed to the strip and rests upon a post when the receiver is down. The wires pass out through the fibre and through a bushing in the base of the instrument. The whole is held together by fall or become damaged in any way the contacts can not become broken or damaged in any degree, and all dirt and dust are kept from them, avoiding untimely corrosion and deterioration. This desk set is manufactured by the Haines & Noyes Company, Chicago, Ill.

THE CONVENTION OF THE AMERICAN STREET RAILWAY ASSOCIATION.

TRANSPORTATION ARRANGEMENTS FOR THE MEETING OCTOBER 8, 9 AND 10, AT DETROIT, MICH.

The transportation committee of the American Street Railway Association has completed special arrangements with the railway companies of several sections of the country for the transportation of delegates and visitors to the convention at Detroit, Mich., October 8, 9 and 10. The New York and New England delegation will have a special train with which connections may be made by those living in cities throughout the eastern district. Other car schedules have also been arranged from western and southern points to Detroit. The committee has issued the following bulletin, containing detailed information regarding arrangements from all parts of the country: A special train will be provided, with Pullman buffet, smoking and drawing-room and sleeping cars, from New York and Boston, as per schedule, under the charge of a special passenger agent of the New York Central. The route is over the Boston & Albany Railway, leaving Boston 2 P. M., Worcester 3.05 P. M., Springfield 4.29 P. M., Pittsfield 6.08 P. M., arriving at Albany 7.30 P. M., Tuesday, October 7. Over the New York Central—leave New York 4 P. M., Poughkeepsie 5.56 P. M., Hudson 6.53 P. M., arriving at Albany 7.35 P. M. Leave Albany 7.40 P. M., Schenectady 8.10 P. M., Fonda 8.45 P. M., Utica 9.54 P. M., Syracuse 11.15 P. M., Tuesday, October 7; Rochester 1.05 A. M., Buffalo 3 A. M., arriving at Detroit on the Michigan Central at 7.45 A. M., Wednesday, October 8. Dining car serving dinner from Boston and New York.

Connections will be made at all New England points, either at Boston, Worcester, Springfield or New York. Applications for sleeping-car accommodations from Boston and Albany points should be addressed to J. L. White, city passenger agent, Boston & Albany Railroad, 366 Washington street, Boston, Mass.; from New York and points on the New York Central, to Milton C. Roach, general eastern passenger agent, New York Central & Hudson River Railroad, 1216 Broadway, New York city.

The schedule of other cars from western and southern points to Detroit, Mich., is as follows: Train leaves Louisville, Pennsylvania lines, 4 P. M.; Indianapolis, Pennsylvania lines, 7.20 P. M.; Logansport, Pennsylvania lines, 9.50 P. M., arriving at Detroit 7.35 A. M. Leave St.

Louis, Wabash Railroad, 8.30 P. M., arriving Detroit, Wabash Railroad, 9.30 A. M. Leave Cincinnati, C. H. & D. R. R., 9.45 P. M., arriving Detroit, Michigan Central, 7.45 A. M. Leave Pittsburg, Pennsylvania lines, 1.05 P. M., arriving Detroit, Michigan Central, 7.45 A. M. Leave Chicago, Michigan Central, 10.30 A. M., 3 P. M., 10 P. M. and 11.30 P. M., arriving Detroit, Michigan Central, 6.10 P. M., 10.45 P. M., 7.35 A. M. and 9.50 A. M.

The various traffic associations have named a fare and one-third on the certificate plan. When purchasing tickets ask the ticket agent for certificate.

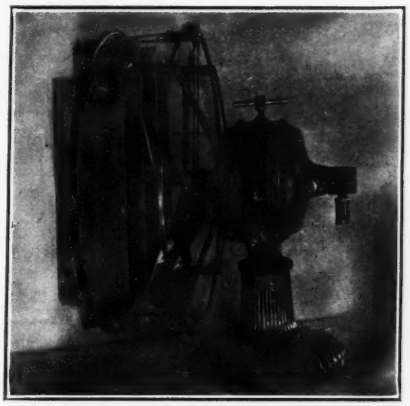
Among the papers to be read at the convention are the following: "The Registration of Transfers," by Mr. C. D. Meenely, Brooklyn Heights Railroad Company; "Benefit Associations," by Mr. O. W. Root, Jr., Metropolitan Street Railway Company, New York; "Discipline of Employés by the Merit System," by Mr. W. A. Satterlee, Metropolitan Street Railway Company, Kansas City; "Transportation of Light Express and Parcel Delivery," by Mr. George W. Parker, Detroit United Railway Company; "Steam Turbine Engine," by Mr. E. H. Sniffen, New York; "Signals for Urban and Interurban Railways, Old Colony Street Railway Company, Boston;" "Adjustment of Damage Claims," Mr. M. B. Starring, Chicago Street Railway Company.

Thursday, October 9, has been set apart as exhibitors' day. No session of the association will be held, so that the members will have ample time to examine the exhibits. The headquarters will be at the Cadillac Hotel, the annual dinner being served at this house on Friday evening, October 10, when the officers-elect will be installed.

A Combined Fan Guard and Air Deflector.

To some particular folk the straight blast of air which is projected from the open space before an ordinary fan is objectionable. Notwithstanding the fact that the electric fan from its inception was a pronounced success, and a demand was built up far exceeding the rosiest views of its designers, it is only within a very recent time that modifications have been attached, with a view toward splitting up the current of air delivered from the fan blades, and distributing it to different quarters of a room or ward.

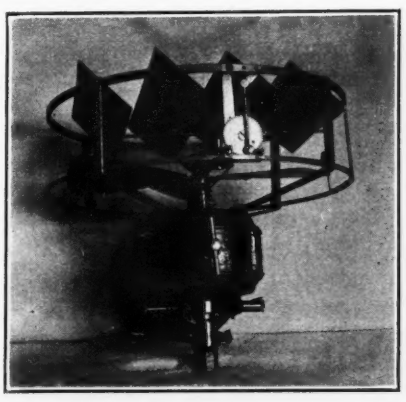
In the accompanying illustration is shown one of the most practical applications of this idea to the ordinary fan which has yet been placed before the public. This consists essentially of a combined fan guard and air deflector. In fitting up the fan with this attachment the ordinary wire guard is removed, and the guard, with the deflectors attached, placed in the relative position. So that the fan guard and deflector might be universally adjustable the attachment arms are slotted for about an inch and a half



FAN GUARD AND AIR DEFLECTOR.

from their extremities, which gives a possibility of increasing or decreasing a radius within this range. For adjustment on the arc of the fan guard the attachment arms are fastened to the outer rim with a strap attachment, which allows of their being slipped to and fro on the wire.

The mechanism which operates the deflecting blades is very simple. The fan blades are slipped off of the fan shaft, and a grooved pulley of small dimensions slipped on next to the motor frame and



TOP VIEW, SHOWING ACTUATING MECHANISM.

behind the fan. This is belt-connected to a second pulley set in a bearing at the top of the fan guard, the shaft of which ends in a worm which engages with a toothed disc. From this toothed disc to the upper extremity of one of the deflectors is fastened a short, light rod, driving it with a regular piston stroke. The throw of the blades can be regulated by varying the distance from the centre at which the driving rod is attached to the toothed disc, and the rapidity of reversal may be regulated by changing the size of the secondary driving pulley.

This attachment may be worked irrespective of the speed of the armature or of the position of the fan. It will operate equally well on a desk or a wall fan, or suspended from the ceiling. It is not necessary to keep up a terrific speed in order that the deflector blades may get a proper pitch. The mechanical control is positive in all directions; it deflects the current of air whether it comes with great velocity or in very small volume, and the pull on the fan shaft is inappreciable.

This arrangement is known as the "Palm" combined fan guard and air deflector, and is manufactured by the Coleman Manufacturing Company, 111 Fifth avenue, New York city. The company will not make fan motors, but will manufacture this apparatus exclusively and sell it to fan-motor manufacturers.

Indiana Electrical Association's Meeting.

Forty members of the Indiana Electrical Association met on September 17 at the Dennison House, Indianapolis, Ind., and discussed the conditions of business in their state. The association is made up of power-house owners and general managers of electrical plants operating in Indiana, and was formed in Indianapolis in May. The officers elected at the May meeting are: T. C. McReynolds, of Kokomo, president; J. N. Harding, of Laporte, vice-president, and H. C. Kimbrough, of Muncie, secretary and treasurer. These elections were ratified at the recent meeting. The meeting was opened by a presidential address and an explanation of the programme for the two days' meeting. Secretary Kimbrough presented a report and talked for a few minutes on the prospects for the growth of the association. A. M. Barron, of Franklin, followed Mr. Kimbrough with a paper, entitled "What We Hope to Accomplish by This Organization." Owing to the absence of Mr. J. S. Clark, of Terre Haute, who was to have read a paper on "Kinds of Indiana Coal Used, and Results Obtained," the paper of H. C. Kimbrough, on "The Best Way of Dealing with Gas as a Competitor," was substituted. Mr. Kimbrough's paper dealt with the proposition of electrical men competing with the gas companies in placing lights in stores and business houses.

In the session of September 18, Mr. C. F. Hewitt, of Elkhart, read a paper on "Rates by Meter, and Otherwise," followed by a paper by J. H. Harding, of Laporte, on "By-Products," and this was followed by Mr. Clark's paper on the coal question.

A luncheon was tendered to the delegates of the association by the local electrical supply men.

WASHINGTON, BALTIMORE & ANNAPOLIS SINGLE-PHASE RAILWAY.

(Continued from page 453.)

to the supports which carry the rotor. Therefore the objectionable controller of the standard direct-current system can be eliminated, provided a suitable alternating-current motor can be obtained. This ideal type of controller is not applicable to the polyphase railway motor, in which speed control can be obtained only through rheostatic loss. The polyphase control system is even more complicated than the direct-current, as there must be a rheostat for each motor, and two or three circuits in each rheostat. It is thus apparent that by the use of single-phase alternating current with an alternating-current motor having the characteristics of the direct-current series motor, the best features of the direct-current system can be obtained, and at the same time many of its disadvantages can be avoided.

This portion of the problem therefore resolves itself into the construction of a single-phase motor having the characteristics of the direct-current series motor. There are several types of single-phase alternating-current motors which have the series characteristics. One type is similar in general construction to a direct-current motor, but with its magnetic circuit laminated throughout, and with such proportions that it can successfully commutate alternating current. Such a motor is a plain series motor, and can be operated on either alternating or direct current and will have the same torque characteristics in either case. Another type of motor is similar in general construction to the above, but the circuits are arranged in a different manner. The field is connected directly across the supply circuit, with proper control appliances in series with it. The armature is short-circuited on itself across the brushes, and the brushes are set at an angle of approximately forty-five degrees from the ordinary neutral point. The first of these two types of motors is the one best adapted for operation in large units.

This is the type of motor which is to be used on the Washington, Baltimore & Annapolis Railway. Several motors have been built and tested with very satisfactory results, both on the testing stand and under a car. The results were so favorable that the system was proposed to the Cleveland Engineering Company, representing the Washington, Baltimore & Annapolis Railway, and after investigation by its engineers it was adopted. A description of the apparatus to be used on this road will illustrate the system to good advantage.

Single-phase alternating current will be supplied to the car at a frequency of sixteen and two-thirds cycles per second, or 2,000 alternations per minute. The current from the overhead trolley wire is normally fed in by one trolley at approximately 1,000 volts. Within the limits of the District of Columbia two trolleys are employed, as by Act of Congress the use of rails as conductors is prohibited in this district, presumably on account of electrolysis. In this case, the trouble, of course, will not exist, but the contracting company has been unable to obtain permission for the grounded circuit.

The alternating current to the car is carried through a main switch or circuit-breaker on the car, to an auto-transformer connected between the trolley and the return circuit. At approximately 300 volts from the ground terminal a lead is brought out from the auto-transformer and passes through the regulator to one terminal of the motors. For starting and controlling the speed an induction regulator is used, with its secondary winding in series with the motors. This secondary circuit of the regulator can be made either to add to or subtract from the transformer voltage, thus raising or lowering the voltage supplied to the motors. The regulator therefore does double duty. The controller for direct-current motors merely lowers the voltage supplied to the motors but can not raise it, but an alternating-current regulator can be connected for an immediate voltage, and can either raise or lower the motor voltage. In this way the regulator can be made relatively small, as it handles only the variable element of the voltage and the maximum voltage in the secondary winding is but half of the total variation required.

In the equipments in question, the range of voltage at the motor is to be varied approximately 200 volts up to 400 volts, or slightly higher. The transformer on the car will supply 315 volts, and the secondary circuit of the regulator will be wound to generate slightly more than 100 volts when turned to the position of its maximum voltage. This voltage of the regulator is about one-fourth of that of the motors at full voltage. The regulator can consequently be made relatively small, in comparison with the motor capacity of the equipment. It has been found unnecessary to use much lower than 200 volts in this installation, as this voltage allows a comparatively low running speed, and approximately 200 volts will be necessary to start with the required torque. The greater part of this voltage is necessary to overcome the electromotive force of self-induction in the motor windings, which is dependent upon the current through the motor and is independent of the speed of the armature.

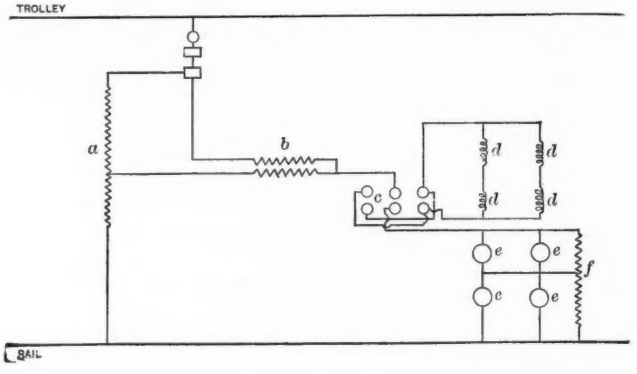


FIG. 1.—*a*. AUTO-TRANSFORMER. *b*. INDUCTION REGULATOR. *c*. REVERSING SWITCH. *d*. FIELD OF MOTORS. *e*. ARMATURE OF MOTORS. *f*. EQUALIZING TRANSFORMER.

There will be four motors of 100 horsepower on each car. The full rated voltage of each motor is approximately 220 volts. The motors are arranged in two pairs, each consisting of two armatures in series and two fields in series, and the two pairs are connected in parallel. The motors are connected permanently in this manner. Since voltage control is used, there is no necessity for series parallel operation, as with direct-current motors. To ensure equal voltage to the armatures in series, a balancing or equalizing action is obtained by the use of a small auto-transformer connected permanently across the two armatures in series with its middle point connected between them. The fields are arranged in two pairs, with two fields in series and two pairs in multiple. This, therefore, parallels the fields independently of the armatures, which was formerly the practice with direct-current

motors. It was a defective arrangement with such motors, as equal currents in the field did not ensure equal field strengths in the motors, and the armatures connected in parallel, therefore, would be operating in fields of unequal strength, with unequal armature currents as a direct result. With alternating currents in the fields the case is different. The voltage across the fields is dependent upon the field strengths, and the current supplied to the fields naturally divides itself for equal magnetic strengths. The chief advantage in paralleling the fields and armatures independently is that one reversing switch may serve for the four motors and one balancing transformer may be used across the two pairs of armatures. The ordinary direct-current arrangement of armatures in series with their own fields can be used, with a greater number of switches and connections.

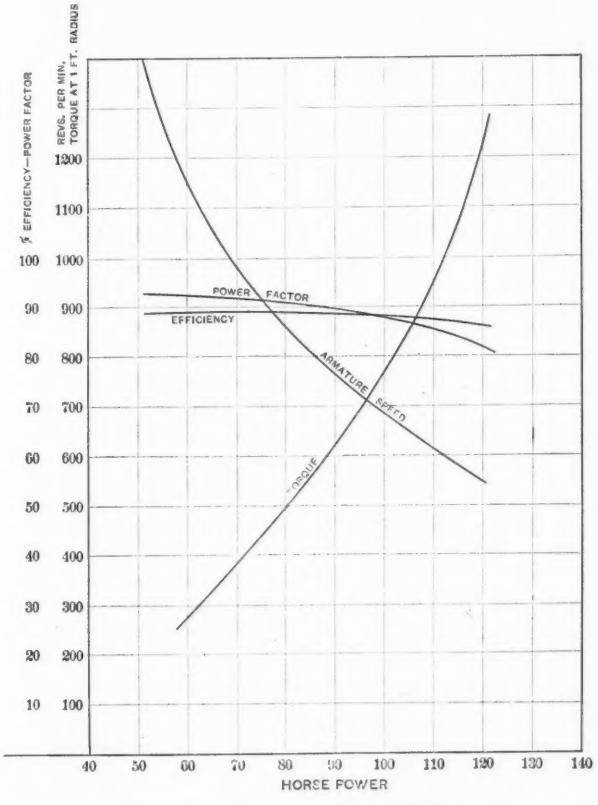


FIG. 2.—WESTINGHOUSE ALTERNATING-CURRENT RAILWAY MOTOR. NO. 91.—SINGLE-PHASE—220 VOLTS.

The general arrangement of the auto-transformer, regulator, motors, etc., is shown in Fig. 1.

The induction regulator or controller resembles an induction motor in general appearance and construction. The primary winding is placed on the rotor, and the secondary or low-voltage winding on the stator. The motor also has a second winding which is permanently short-circuited on itself. The function of this short-circuited winding is to neutralize the self-induction of the secondary winding as it passes from the magnetic influence of the primary. The regulator is wound for two poles, and therefore is operated through 180 degrees in producing the full range of voltage for the motors. One end of the primary winding of the regulator is connected to the trolley, and the other to a point between the regulator and the motors. It thus receives a variable voltage as the controller is rotated. There are several advantages in this arrangement of the primary in this particular case. First, the regulator is worked at a higher induction at start, and at lower induction when running, the running position being used in these equipments for much longer periods than required for starting. Second, when the motors are operating at full voltage the current in the primary of the regulator passes through the motors but not through the auto-transformer or the secondary of the regulator. This allows considerable reduction in the size of the auto-transformer and regulator.

The motors on the car are all of the straight series type. The armature and fields being connected in series, the entire current of the field passes through the armature as in ordinary series direct-current motors. The motor has eight poles, and the speed is approximately 700 revolutions at 220 volts. The general construction is similar to that of a direct-current motor, but the field core is laminated throughout, this being necessary on account of the alternating magnetic field. There are eight field coils wound with copper strap, and all connected permanently in parallel. The parallel arrangement of field coils assists in equalizing the field strength in the different poles, due to the balancing act of alternating circuits in parallel. This arrangement is not really necessary, but it possesses some advantages and therefore has been used. With equal magnetic strength in the poles, the magnetic pull is equalized even with the armature out of centre.

The armature is similar in general construction to that of a direct-current motor. The fundamental difficulty in the operation of a commutator type of motor on single-phase alternating current lies in the sparking at the brushes. The working current passing through the motor should be practically no more difficult to commutate than an equal direct current, and it is not this current which gives trouble. The real source of trouble is found in a local or secondary current set up in any coil, the two ends of which are momentarily short-circuited by a brush. This coil encloses the alternating magnetic field, and thus becomes a secondary circuit, of which the field coil forms the primary. In the motors of the Washington, Baltimore & Annapolis Railway, this commutation difficulty has been overcome by so constructing the motor that the secondary or short-circuit current in the armature coil is small, and the commutating conditions so nearly perfect that the combined working and secondary currents can be commutated without sparking. This condition being obtained, the motor operates like a direct-current machine and will give no more trouble at the commutator than ordinary direct-current railway motors. Experience covering a considerable period in the operation of motors of 100-horse-power capacity indicates that no trouble need be feared at the commutator.

An extended series of tests were made with these motors at the Westinghouse shops, at Pittsburg, both in the testing room and under a car. Fig. 2 shows curves of the speed, torque, efficiency and power-factor plotted from data from brake tests.

It should be noted that the efficiency is

good, being very nearly equal to that of high-class direct-current motors. The power-factor, as shown in these curves, is highest at light loads and decreases with the load. This is due to the fact that the power developed increases approximately in proportion to the current, while the wattless component of the input increases practically as the square of the current. The curve indicates that the average power-factor will be very good. The calculations for the Washington, Baltimore & Annapolis Railway show that the average power-factor of the motors will be approximately eighty-six per cent.

The average efficiency of these equipments will be much higher during starting and accelerating than that of corresponding direct-current equipments, as rheostatic losses are avoided. When running at normal full speed, however, the efficiency will be slightly less than with direct current. This is due to the fact that the alternating-current motor efficiency is slightly lower than the direct current, and in addition there are small losses in the transformer and the regulator. The alternating-current equipments are somewhat heavier than the direct current, thus requiring some extra power, both in accelerating and at full speed. Therefore, for infrequent stops the direct-current car equipment is more efficient than the alternating current, but for frequent stops the alternating current shows the better efficiency. Tests on the East Pittsburg track verified this conclusion. But the better efficiency of the direct-current equipment with infrequent stops is offset with the alternating current by decreased loss in the trolley wire, by reason of the higher voltage used, and by the elimination of the rotary converter losses. The resultant efficiency for the system will therefore be equal to or better than that of the direct current.

In the Washington, Baltimore & Annapolis Railway contract the guarantee given by the Westinghouse Electric and Manufacturing Company states that the efficiency of the system shall be equal to that of the direct-current system with rotary converter substations.

There is one loss in the alternating-current system which is relatively much higher than in the direct current. This is the loss in the rail return. Tests have shown that at 2,000 alternations it is three to four times as great as with an equal direct current. This would be a serious matter in cases where the direct-current rail loss is high. But the higher alternating-current trolley voltage reduces the current so much that the alternating-current rail loss is practically the same as with direct current at usual voltages. In many city railways the direct-current rail loss is made very low, not to lessen waste of power, but in order to reduce electrolysis. In such cases the alternating-current rail loss could be higher than direct current, thus decreasing the cost of return conductors. More numerous transformer substations, with copper feeders connected to the rails at short intervals, will enable the rail loss to be reduced to any extent desired.

As a frequency of 2,000 alternations per minute is used, the lighting of the cars and the substations was at first considered to be a serious difficulty, due to the very disagreeable winking of ordinary incandescent lamps at this frequency. Two methods of overcoming the winking were tried, both of which were successful. One method was by the use of split phase. A two-phase induction motor was run on a single-phase 2,000 alternating circuit, and current was taken from the unconnected primary circuit of the motor. This current was, of course, at approximately ninety degrees from the current of the supply circuit. A two-phase circuit was thus obtained on the car. Currents from the two phases were put through ordinary incandescent lamps placed close together. The resulting illumination a few feet distant from the lamps showed about the same winking as is noticed with 3,000 alternations. With two filaments in one lamp the winking disappears entirely. A three-phase arrangement would work in the same way.

A much simpler method was tried which worked equally well. This consisted in the use of very low-voltage lamps. Low voltage at the lamp terminals allows the use of a thick filament with considerable heat inertia. Tests were made on lamps of this type at a frequency of 2,000 alternations, and the light appeared to be as steady as that from the ordinary high-frequency incandescent lamp. The low voltage is not objectionable in this case, as a number of lamps can be run in a series, as in ordinary street railway practice, and any voltage desired can readily be obtained, as alternating current is used on the car.

There will be an air compressor, driven by a series alternating-current motor, on each car, for supplying air to the brakes and for operating the driving mechanism of the controller. The details of this mechanism are not sufficiently near to completion to permit a description of it. The method used will be one which readily allows operation on the multiple-unit system.

The generating station contains some interesting electrical features, but there is no great departure from the usual alternating-current practice. There will be three 1,500-kilowatt single-phase alternators. These are twenty-four-pole machines operating at eighty-three revolutions and wound for 15,000 volts at the terminals. They are of the rotating field type, with laminated magnetic circuits and field coils of strap on edge. The field coils are held on the pole-tips by copper supports, which serve also as dampers to assist in the parallel running. The armatures are of the usual slotted type. The armature coils are placed in partially closed slots. There are four coils per pole. The proportions of these machines are such that good inherent regulation is obtained without saturation of the magnetic circuit. The rise in potential with non-inductive load thrown off will be approximately four per cent. An alternative estimate was furnished for the generators proposing 20,000 volts instead of 15,000. The simplicity of the type of winding used, and the low frequency, are both favorable for the use of very high voltage on the generator. As 15,000 volts was considered amply high for the service, the engineers for the railway considered it inadvisable to adopt a higher voltage.

There are to be two exciters, each of 100 kilowatts capacity at 250 revolutions. The exciters are wound for 125 volts normal. The armature of each exciter has, in addition to the commutator, two collector rings, so that single-phase alternating current can be delivered. It is the intention to use the exciters as alternators for supplying current to the system for lighting when the large generators are shut down at night.

The main station switchboard comprises three generator panels, one load panel and three feeder panels. High-tension oil-break switches are to be provided, operated by means of controlling apparatus on the panels. The switches, bus-bars and all high-tension apparatus will be in brick compartments separate from the board. In each generator circuit there are two non-automatic oil-break switches in series, and on each feeder circuit there are two overload time-limit oil-break switches in series. The two oil-break switches in series on the same circuit can be closed separately and then opened to test the switches without closing the circuit. With the switches in the closed position they are both operated

at the same time by the controlling apparatus to ensure opening of the circuit, and to put less strain on the switches, although either one is capable of opening the load. There will be nine transformer substations distributed along the railway line. Each station will contain two 250-kilowatt oil-cooled lowering transformers, supplying approximately 1,000 volts to the trolley system. Two transformers are used in each station, so that in case of accident to one transformer the station will not be entirely crippled.

It is the intention of the railway company to operate a direct-current road already equipped with the direct-current system. The present direct-current car equipments are to be retained, but the current will be supplied from a rotary converter substation fed from the main system of the Washington, Baltimore & Annapolis Railway. As this system is single-phase, it is necessary that single-phase rotaries be used in the substations. There are to be two 200-kilowatt 550-volt rotary converters. These are four-pole 500-revolution machines. The general construction of these machines is very similar to that of the Westinghouse polyphase rotary converters. The armature resembles that of a polyphase rotary, except in the number of collector rings, and in certain details of the proportions made necessary by reason of the use of single-phase. The commutating proportions are so good that any reactions due to the use of single-phase will result in no injurious effect. The field construction is similar to that of a polyphase rotary. The laminated field poles are provided with dampers of the "grid" or "cage" type, a form used at present in the Westinghouse polyphase rotary converters. These dampers serve to prevent hunting, as in the polyphase machines, and also to damp out pulsations due to single-phase currents in the armature. The damper acts to a certain extent as a second phase. Each rotary converter is started and brought to synchronous speed by a small series alternating-current motor on the end of the shaft. The voltage at the motor terminals can be adjusted either by loops from the lowering transformer or by resistance in series with the motor, so that true synchronous speed can be given to the rotary converter before throwing it on the alternating-current line.

From the preceding description of this system and the apparatus used on it, some conclusions may be drawn as to the various fields where it can be applied to advantage. It is evident that a good field for it will be on interurban long-distance lines such as the Washington, Baltimore & Annapolis Railway. On such railways, high trolley voltage and the absence of converter substations are very important factors.

For heavy railroading also, this system possesses many ideal features. It allows efficient operation of large equipments at practically any speed and any torque, and also avoids the controller troubles which are ever present with large direct-current equipments. It also permits the use of high trolley voltage, thus reducing the current to be collected. In this class of service the advantages of this alternating-current system are so great that it is possible that heavy railroading will prove to be a special field for it.

For general city work this system may not find a field for some time to come, as the limitations in the present system are not so great that there will be any urgent necessity for making a change. It is probable that at first it will be applied to new railways or in changing over steam roads rather than in replacing existing city equipments. One difficulty with which the new system will have to contend is due to the fact that the alternating-current equipments can not conveniently operate on existing direct-current city lines, as is the present practice where interurban lines run into the cities. It will be preferable for it to have its own lines throughout, unless very considerable complication is permitted. When the alternating-current system applied to interurban and steam railways finally becomes of predominant importance, it is probable that the existing direct-current railways will gradually be changed to alternating current as a matter of convenience in tying the various lines together.

As was stated above, alternating-current equipments can not conveniently be operated on direct-current lines. It does not follow, however, that the motor will not operate on direct current. On the contrary, the motor is a first-class direct-current machine, and if supplied with suitable control apparatus and proper voltage it will operate very well on the direct-current lines. This would require that the motors be connected normally in series, as the voltage per motor is low. A complete set of direct-current control apparatus would be needed when the alternating-current equipment is to be run on direct current, and considerable switching apparatus would be necessary for disconnecting all the alternating-current control system and connecting in the direct current. The complication of such a system may be sufficient to prevent its use, at least for some time to come.

In some cities very strict laws are in force in regard to the voltage variations in various parts of the track system. The permissible variations are so small in some cases that an enormous amount of copper is used for return conductors; and in some cases special boosters are used in the return circuits to avoid large differences of potential between the various parts of the track system. The object in limiting the conditions in this manner is to avoid troubles from electrolysis. The alternating-current system will, of course, remedy this.

For city work it is probable that voltages of 500 or 600 would be employed instead of 1,000 or higher. The transformers and controllers can be designed to be readily changed from full to half voltage, so that low voltage can be used on one part of the line and high voltage on another. As the car equipments of such railways are usually of small capacity, it is probable that speed control will be obtained by means of a transformer with a large number of leads carried out to a control drum, rather than by means of the induction regulator, as the latter device is much more expensive in small units. This is chiefly a question of cost, and if the advantages of the induction regulator are found to overweigh the objection of the high first cost, then it will be used even on small equipments.

In the Washington, Baltimore & Annapolis Railway, the generators are wound for single-phase. In the case of large power stations with many feeders the generators may be wound for three-phase, with single-phase circuits carried out to the transformer substation; or three-phase transmission may be used, with the transformers connected in such a manner as will give a fairly well-balanced three-phase load.

There are many arrangements and combinations of apparatus made possible by the use of alternating current in the car equipment which have not been mentioned, as it is impracticable to give a full description of all that can be done. But enough has been presented to outline the apparatus and to indicate the possibilities of this new system, which is soon to see the test of commercial service.

Large Turbo-Alternator at Neptune Bank, Wallsend.

A brief illustrated note describes a new turbo-alternator which has just been installed at the Neptune Bank station. The generator runs at 1,200 revolutions per minute, with a frequency of forty cycles per second, pressure of from 500 to 600 volts, and has an output of 1,500 kilowatts. The results of a recent test are as follows: Speed, 1,200 revolutions per minute; load, 1,442 kilowatts; steam pressure, 196 pounds per square inch; superheat, 76 degrees Fahrenheit; vacuum, 27 inches. Steam consumption per kilowatt-hour was found to be 18 pounds.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

ELECTRIC POWER TO IRRIGATE RICE FIELDS—Word comes from New Orleans that the Southern Pacific Railroad is behind a plan for the equipment of rice plantations in Louisiana and Texas with electric power for mill irrigation pumps and harvesting machinery. It is also announced that a 10,000-acre rice plantation on the Southern Pacific line in Harris County, Texas, will be so equipped.

A BIG MICHIGAN TROLLEY COMBINATION RUMORED—It is announced that a company to be known as the Michigan Trolley Combination will be formed at Detroit, with a capital of from $30,000,000 to $40,000,000, to combine all electric lines in the lower Michigan peninsula, with the exception of the Detroit United Railways and the Monroe & Toledo company. It is said that the new company may be formed within thirty days. Westinghouse interests, Hawkes & Angus, and New York parties are reported to be in the deal.

A RUSSIAN WATER-POWER SCHEME—The Russian Government is reported to have granted a concession to a Russian company for the utilizing of water power on the Marva and Miatra rivers, for the purpose of furnishing electricity for public lighting and general power purposes to St. Petersburg. Power will be transmitted a distance of 188 miles. It is said that over 200,000 horsepower is available. The scheme will entail an expenditure of not less than $14,000,000. It is also proposed to make use of the great Dnieper Cataracts for the generating of electricity.

WIRELESS TELEGRAPH ON LAND—Letters and words were successfully transmitted by wireless telegraphy between the Naval Academy at Annapolis, Md., and Washington last week. The system which was successfully used was the Slaby-Arco, which was installed by representatives sent to this country for that purpose. The experiments here are under the charge of Lieutenant J. M. Hudgins, assisted by Chief Electricians J. H. Bell and N. C. Bean. The United States ship Perry will be at Annapolis about October 10, and experiments in signaling from the land to that vessel will then be conducted.

DIFFICULTIES IN REPAIRING ST. VINCENT CABLE—While the cableship Newington was repairing the St. Lucia end of the St. Vincent cable on the afternoon of Sunday, September 21, four and one-half miles from Mount Souffriere on the Island of St. Vincent, a violent eruption of the volcano forced the steamer to suspend operations, allowing it a very small margin of escape. It is considered inadvisable to engage in further operations there, especially as the cable has been found to be greatly torn. The Newington will now proceed to complete the repairing of the St. Lucia-Grenada section.

NEW NORTH SEA CABLE—The telephone cable which crosses the North Sea between St. Margaret's, near Dover, England, and La Panne, a watering place in Belgium, has been completely laid and communication with London has been established. It is expected that within a few months direct telephonic communication will be established between London and Brussels. When the line is open the public will be able to correspond with Brussels from all telephone stations, this applying only to the subscribers of the Post Office Telephone system. The charge is said to be $2 for three minutes' conversation.

BIG PHILADELPHIA COMPANIES MAY COMBINE—Persistent rumors are being voiced regarding an approaching consolidation of the interests of the Philadelphia Rapid Transit Company and the Philadelphia Electric Company. The latest plans of the combination are reported to include the American Railways Company and the Electric Company of America. It is said, according to the Philadelphia press, that the merging of these interests will be perfected by means of a new securities company, to operate under a New Jersey charter. A syndicate headed by P. A. B. Widener, William L. Elkins and John H. Mack, which owns the Philadelphia Rapid Transit Company, is now said to control the Philadelphia Electric Company as well. Several of the directors of these two companies are also directors of the Electric Company of America, and are associated with the directorate of the United Gas Improvement Company.

A NEW TROLLEY TUNNEL TO CONNECT IMPORTANT TERMINALS—The plans of the Hudson & Manhattan Railway Company, incorporated under the laws of New Jersey with a capital stock of $100,000, were partly disclosed in Jersey City recently. The company proposes first to build a tunnel under the land in Jersey City, skirting the Hudson River from the Erie Railroad at Pavonia avenue south to the terminal of the Jersey Central at Communipaw, passing under the river station of the Pennsylvania Railroad. The charter also authorizes the company to operate cars in a tunnel under the Hudson as far as the boundary line between New Jersey and New York, where it will connect with a tunnel to be constructed by a company to be incorporated under the laws of New York. The proposed tunnel will be a feeder for the river trolley tunnel and will permit passengers to go from New York to Erie, Pennsylvania and Central railroads in a few minutes.

NEW TELEPHONE SYNDICATE — The International Telephone Company has filed a deed of trust at Wilmington, Del., through Josiah Marvel, for $100,000,000. This covers plants already secured, patents covering the manufacture of switchboards and general telephone apparatus, and the franchises the concern expects to secure. It is proposed to issue bonds amounting to $100,000,000, underwritten by New York and Baltimore capitalists. It is alleged that telephone service will be incorporated at a very much reduced charge for conversation. The International company was incorporated at Dover on May 15 with a nominal capital of $1,000,000. It is stated that another certificate will soon be filed, calling for a capital of $200,000,000, and the fee received by the state will amount to about $30,000. The company already has plants in operation in Louisiana. The officers are: S. B. Rhinehart, of Waynesboro, Pa., president; Ehlen B. Harrison, of Baltimore, treasurer; Henry F. Fahey, of New York, secretary; J. Miller Kenyon, of Washington, D. C., secretary.

NEW TRI-STATE TROLLEY LINE—The Bennington & Hoosick Valley Railway Company purposes to build extensions in three directions. These extensions, with connecting lines, will give through service from Troy to Bennington, as well as from North Adams to Pittsfield and other towns in that vicinity; also through service from the Glen's Falls territory in almost a straight line to the North Adams and Pittsfield territory. The amount of line to be constructed is as follows: Twenty-six miles from Troy to North Hoosick, sixteen miles from Eagle Bridge to Greenwich, and fourteen miles from Hoosick Falls to the Massachusetts state line, where it will connect with the North Adams, Pittsfield & Berkshire Street Railway Company's lines. At Greenwich it will connect with the Hudson Valley, Troy & New England, and Troy & Schenectady lines, and at Albany with the Albany & Schenectady and Albany & Hudson trolley roads. The new system will be seventy-two miles long, and will pass through or touch thirty-four cities, towns, villages and settlements. The line, when completed, will be a fast interstate road, doing business in New York, Vermont and Massachusetts.

LEGAL NOTE.

INCANDESCENT LAMP SUIT—A suit has been filed by the General Electric Company against the United States Incandescent Lamp Company, of St. Louis, Mo., on the Malignani patent No. 537,693, dated April 16, 1895. The suit is pending in the circuit court of the United States at St. Louis, and the patent is alleged to cover the chemical exhaustion of incandescent lamps.

ELECTRICAL SECURITIES.

According to the last bank statement, liquidation was by no means as heavy as expected, loans being decreased only by about $13,350,000. The condition of the associated banks has been decidedly improved, as they now show a surplus of $3,236,000, as against a deficit last week of $1,642,000. The condition last week, however, might rightly be termed one of stringency, and it was but natural that the money outlook should dominate the stock market. As the New York market is still drained by sub-treasury absorptions and interior transfers for crop-moving purposes, it will be more than surprising if a firm monetary situation does not prevail through the balance of the year, or at least until the return flow of money from the interior sets in in volume.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 27.

New York:	Closing.
Brooklyn Rapid Transit	66¼
Consolidated Gas	220½
General Electric	190
Kings County Electric	210
Manhattan Elevated	137⅛
Metropolitan Street Railway	142
New York & New Jersey Telephone Co.	157
Westinghouse Manufacturing Co.	222

The directors of the New York & New Jersey Telephone Company have voted to increase the capital stock of the company by $3,125,000, making the total amount of stock now issued $12,500,000. The new stock is offered to stockholders of record at the time of issue at par, in the proportion of one share of the new issue to every three shares of present holdings, or one-third of a share of new stock for each share of the old. The right to subscribe under the offer will expire on November 1.

The Brooklyn Rapid Transit Company's report for August shows gross earnings of $1,226,954, an increase of $94,569 over the same period in 1901. Operating expenses for the month decreased $51,934, and the net earnings increased from $146,504 to $448,363. For the two months to August 1, the gross earnings were $2,263,355, an increase of $132,413. Operating expenses were $1,274,192, a decrease of $93,442, and the net earnings were $1,189,163, an increase of $225,855.

The general balance sheet of the Metropolitan Street Railway Company for June 30, 1902, compared with the same date the year preceding, shows the total assets to be $106,489,817, as against $90,534,746 in 1901, an increase of $15,955,071.

Boston:	Closing.
American Telephone and Telegraph	169
Edison Electric	275
Massachusetts Electric preferred	96
New England Telephone	140
Western Telephone and Telegraph	100

The stockholders of the Boston Elevated Company have taken practically the entire issue of 33,000 shares of new stock at $155 per share. Less than 1,000 shares were unsubscribed for. A large amount of the stock was absorbed by small stockholders.

The American Telephone and Telegraph Company has declared a dividend of $1.50 per share, payable October 15.

Philadelphia:	Closing.
Electric Company of America	9¾
Electric Storage Battery common	89
Electric Storage Battery preferred	88
Philadelphia Electric	8¾
Union Traction	47⅛
United Gas Improvement	113⅛

The bulk of business in the local market last week was in Union Traction and Philadelphia Electric. Philadelphia Rapid Transit was in considerable demand up to 16⅜, the same parties being buyers of Union Traction up to 47¼. Liquidation continued in Electric Company of America, but the stock was well taken.

The Electric Storage Battery Company has declared a dividend of 1¼ per cent on both the common and preferred stock, which was payable October 1.

The United Gas Improvement Company has declared the quarterly dividend of 2 per cent, payable October 15.

The Union Traction directors have organized by the reelection of the old officers.

Chicago:	Closing.
Chicago Edison Light	174
Chicago Telephone	168
Metropolitan Elevated preferred	89
National Carbon common	33
National Carbon preferred	101
Union Traction common	17
Union Traction preferred	51

PERSONAL MENTION.

MR. ROBERT LOZIER, of Cincinnati, has been in New York during the past few days.

MR. JAMES A. MYERS, president of the Robbins & Myers Company, of Springfield, Ohio, has been in the East during the past week.

MR. J. C. FISH, Shelby, Ohio, made a brief visit to New York during the past few days. Mr. Fish is prominently identified with the incandescent lamp industry.

Mr. WILLIAM COALE, treasurer of the Sterling Electrical Manufacturing Company, Warren, Ohio, has been in New York and New England cities during the last few days.

MR. W. F. MALLOY, secretary of the Bridgeport Brass Company, has returned to business at the New York office of the company after a severe attack of rheumatism.

MR. JOSEPH F. BECK has been elected general manager of the Providence Telephone Company, succeeding the late Mr. A. C. White. Mr. Beck has long been identified with the company and is an able and progressive telephone manager.

MR. C. S. DRUMMOND, of the British Electric Traction Company, it is reported, has resigned as director of that concern. Mr. Drummond has recently become president of the Manhattan Transit Company, and is working assiduously for the introduction of automobile transportation in large cities.

MR. CARL SCHWARTZ, an electrical engineer of Germany who has been prominent in important construction work in that country and in Russia, has been in New York during the past few days. He is making a tour of inspection of the leading electrical machinery manufactories of the United States.

DR. HARRY C. JONES, associate professor of physical chemistry at the Johns Hopkins University, will deliver a course of six lectures upon physical chemistry at the Brooklyn Institute of Arts and Sciences. The first of these will be given Monday, October 6, and the subject will be "The Rise of the New Physical Chemistry."

A CHRISTIANA DESPATCH says the University of Christiana has been celebrating the one-hundredth anniversary of the birth of Niels Henrik Abel, the famous Norwegian mathematician. Twenty-nine foreign men of science received the degree of *Doctor Honoris Causa*, among them being Professor George Howard Darwin, Professor Forsyth, Lord Kelvin, Lord Rayleigh and Sir George Gabriel Stokes.

MR. FRANK B. KNIGHT, special agent of the American Telephone and Telegraph Company, with headquarters at Dallas, Tex., has been visiting for a few days with New York friends. On Tuesday of this week a luncheon was tendered to him by several members of the "Old Guard Electrique," which was organized in 1884. The event occurred at the French restaurant conducted by Messrs. Louis and Henry Mouquin, and reminiscences of early electrical days were freely indulged in. Among those present, in addition to the guest, were E. T. Gilliland, W. D. Sargent, W. L. Candee, John C. Reilly, H. L. Storke and Lieutenant F. W. Toppan, U. S. N.

RECEIVERSHIP NOTE.

ELECTRIC VEHICLE RECEIVER—The American Electric Vehicle Company was placed in the hands of a receiver, the application being made by John R. Hardin, counsel for George F. King, of East Orange, one of the stockholders. The company was incorporated in the state of New Jersey on December 13, 1899, with a capital of $6,000,000. Mr. George P. Lister, Hoboken, N. J., is the president and treasurer of the company. Mr. Charles J. Roe, Jersey City, was appointed receiver.

ELECTRIC LIGHTING.

BALLARD, WASH.—The Ballard city council has passed a resolution declaring in favor of building a new $25,000 electric light plant.

ATLANTA, GA.—A $1,500,000 corporation proposes to dam the Chattahoochie River to utilize the power for furnishing the city with electricity.

GOSHEN, IND.—The common council has granted a fifty-year franchise to the Hawks Electric Company, to operate an electric lighting plant in Goshen.

TIFTON, GA.—A ten-year exclusive franchise and contract for twenty 2,000-candle-power arc lamps has been granted to the Tifton Electric Light Company.

HOMER, N. Y.—This village has voted to establish a municipal lighting plant in connection with its water-pumping station, and appropriated $15,000 therefor.

DENVER, COL.—The Denver Highlands Electric Company has notified the city council that it will shortly ask for a franchise to operate in all parts of the city.

GREAT BEND, N. Y.—The power plant of the Union Electric Company at Hallstead has been moved to Susquehanna and consolidated with the electric light plant at that place.

PITTSBURG, PA.—Plans are being prepared in the Pennsylvania Railroad's engineering department for a power plant in Pittsburg that will furnish the electric current for operating signals on the Monongahela division.

CADILLAC, MICH.—The Cummer Electric and Water Company has been reorganized, but will retain the same name. The members of the new company are: W. W. Cummer, D. F. Diggins, Jacob Cummer, F. A. Diggins and William Saunders.

WINONA, MINN.—The city council has unanimously decided to erect and maintain an electric lighting plant in connection with the waterworks system. The new plant will cost in the neighborhood of $40,000, and will be erected and in operation by April, 1903.

SPRINGFIELD, OHIO—The Dayton, Springfield & Urbana power plant at Medeay, between Springfield and Dayton, is being enlarged to three times its present size, and when completed will furnish power for the entire Appleyard system of interurban roads. The plant will be ready for operation in about three months.

DENVER, COL.—The state department has granted a charter to the Sussex Light, Heat and Power Company, a Georgetown corporation, whose objects and privileges are to operate electric light plants and distribute electricity for both illuminating and heating throughout Sussex County. The capital stock is $25,000.

CENTRALIA, ILL.—The franchises of the Centralia Light and Power Company and the local street railway have been extended nine and eleven years, respectively. It is stated that this was done to promote the sale of the two plants to a party of Chicago capitalists, who intend to consolidate them. The purchasing company contemplates many improvements.

AUGUSTA, GA.—The Twin City Power Company has secured options on both banks of the Savannah River for fourteen miles from a point about twenty-five miles above this city. It is intended to get sufficient power from the river to supply electric railroads, lighting plants and factories within a radius of fifty miles. The engineers state that the company will surely have 40,000 horsepower.

COLUMBUS, GA.—A petition for a charter for the Coweta Power Company, with a maximum capital stock of $1,000,000, has been filed, John J. Baldwin, of Savannah, and John F. Flournoy, of Columbus, being among the incorporators. The company is to develop on a large scale the water power at and above Clapp's factory, and it is understood that with the building of the big fifty-foot dam a number of factories are to be built to utilize the power thus developed.

MONTPELIER, VT.—Articles of association for the Vermont Light, Heat and Power Company have been filed with the Secretary of State. The company is capitalized at $200,000, and among the capitalists identified with it are J. J. Flynn and A. O. Humphrey, of Burlington, and E. E. Carpenter, of Worcester, Mass. It is the intention of the company to construct a power plant at St. Albans to supply light and power for the St. Albans & Swanton Railroad and for manufacturing purposes.

RICHMOND, VT.—The Richmond Light and Power Company, Richmond, Vt., has been incorporated, and a contract let for apparatus. It is expected that the plant will be running by the early part of the winter. The officers are as follows: Doctor B. J. Andrews, president; A. Stevens, treasurer; I. H. Goodwin, secretary; A. V. Hall, manager. The Vermont Electric Company, which has been furnishing light and power for Burlington, Vt., has been sold to the American Gas Company, of Philadelphia, the syndicate which recently bought the local gas and electric company and the Consolidated Electric Company.

PHILADELPHIA, PA.—For the purpose of utilizing the water power obtained from the several waterfalls in lower Pike County, a company known as the United Water Improvement Company has been organized, with the following officers: President and treasurer, J. P. Logan; secretary and general manager, C. Jess Young. The directors of the company are: J. P. Logan, Samuel M. Clements, Jr., Fred Rothermel and C. Jess Young. The company intends building a lake outside the town of Hawley, which will be the largest lake in Pennsylvania. Twenty thousand horse-power will be realized, it is said, and the electricity will be used for lighting and supplying power to the surrounding country. The falls from which the power will be obtained are 285 feet high. Work will be begun on the plant in the fall, and the estimated cost is $1,000,000.

TELEPHONE AND TELEGRAPH.

LIANO, TEX.—The Western Union Company's line will be extended to this village at once.

GRAND RAPIDS, MICH.—Grand Rapids now has a direct line to New York, the Western Union Telegraph Company having recently installed this service.

MEMPHIS, TENN.—The Memphis Long-Distance Telephone Company, St. Louis, Mo., has been chartered with a capital of $1,000,000, to construct, maintain and operate a telephone line between Memphis, Tenn., and Jonesboro, Ark.

HARTFORD, S. DAK.—It is stated that a new telephone system is to be established here by a company composed of local business men. The officers are: President, E. C. Evans; secretary, Henry Schaper; treasurer, I. C. Kingsbery; manager, K. Mueller.

LE ROY, N. Y.—A franchise has been granted to the Inter-Ocean Telephone Company to string and maintain its wires in the village. The company must begin work on its line in the village within sixty days, and the system must be in operation within six months.

LOS ANGELES, CAL.—The Pomona Valley Telephone and Telegraph Company has been incorporated with a capital of $50,000. The directors are: John Law, Pomona; C. B. Summer, Claremont; D. S. Parker, Pomona; J. F. Daniels, Lordsburg; G. W. Ogle, Pomona; A. J. Cook, Claremont; Vincent W. Gaker, Lordsburg.

PHILADELPHIA, PA.—Within the next two months the Keystone Telephone Company expects to have long-distance connections from this city through Wilmington to Baltimore, and by way of Reading and the northeastern part of the state to Williamsport, Harrisburg, Wilkesbarre and Scranton. Every large city in the state, except Pittsburg, will then be connected with Philadelphia. It is stated that New Jersey, Delaware and Maryland will also be covered.

ALBANY, N. Y.—The Chenango Valley Telephone Company has been incorporated for the purpose of connecting Binghamton and Oxford, Rome, Binghamton to Cortland *via* Castle Creek, Hydeville, Whitney's Point, Killawog and Marathon, and other points in Broome, Chenango, Cortland, Delaware, Tioga and Tompkins counties. The directors of the company are: Fred E. Allen, Whitney's Point; Edwin H. Alderman, William H. Stack, Castle Creek; Bradford W. Terry, Fred M. Harding, Chenango Bridge; Charles Van Amberg, Port Crane; Charles H. Peters, Chenango Forks; William Beardsley, Harpursville; Ward Gifford, South Oxford; Charles J. Hayes, Hydeville; W. F. Van Cleve, Binghamton; George H. Day, Brisbane.

ELECTRIC RAILWAYS.

AUSTIN, TEX.—It is stated that the Belton-Temple Electric Railroad, which recently filed its charter in the Secretary of State's office with a capital of $100,000, will be built immediately between Belton and Temple.

ALLENTOWN, PA.—The street railway line between Bangor and East Bangor, operated under the name of the Bangor & East Bangor Street Railway Company, was purchased recently by the East Bangor, Portland & Delaware Street Railway Company.

HURON, MICH.—The city council has passed an ordinance giving the Lake Shore Electric Railway Company the right to build its tracks to the line of the bridge over the Huron River. The company must complete the work by December 1 of this year.

SYRACUSE, N. Y.—The certificate declaring the intention of the Syracuse Rapid Transit Railway Company to extend its line of tracks from Liverpool to Long Branch has been filed with the county clerk. The line will be about two and one-half miles in length.

NASHVILLE, TENN.—The survey for the proposed electric line from Nashville to Lewisburg has been completed. The line begins at the corporate limits of this city, passing through Nolensville, Triune, Chapel Hill and other places in Williamson and Maury counties.

NEWBURGH, N. Y.—At a meeting of the directors of the Intervale Traction Company held recently, the organization of the company was perfected and officers elected as follows: Edward R. Emerson, New York city, president; H. B. Odell, vice-president; Charles W. Griffith, treasurer; W. Johnston McKay, secretary. Arrangements were made to begin a survey of the route at once.

GREENCASTLE, PA.—The stockholders of the newly organized Waynesboro, Greencastle & Mercersburg Turnpike Road Company, which purchased the turnpike leading from McConnellsburg to Emmitsburg, Md., thirty-nine miles long, have elected as officers the men comprising the board of the Chambersburg, Greencastle & Waynesboro Electric Railway Company, and plans for the early building of the line have been made.

COLUMBUS, IND.—An organization has been effected with J. B. Burrell, of Brownesville, as president; L. H. Masters, of Seymour, as secretary, and Morton Hall, of Columbus, as treasurer, to build and operate an electric line from Columbus to French Lick and West Baden Springs, to connect with the Indianapolis, Greenwood and Franklin interurban lines to this city. A preliminary survey will be made at once.

PLATTSBURG, N. Y.—It is rumored that the long talked of trolley road from Saranac Lake, in the Adirondacks, to Westport, on Lake Champlain, *via* Lake Placid, Elizabethtown and Ausable Forks, will soon be built. Surveyors are now at work near Saranac Lake locating the route, and it is expected that the road will be completed in time for next season's business. The distance from Saranac Lake to Westport by this route is sixty miles, connecting several prosperous villages.

INDIANAPOLIS, IND.—A controlling interest in the Indianapolis, Greenwood & Shelbyville Traction Company has been purchased by Harry B. Smith, Hartford City; Edward Hawkins, Indianapolis, and a number of eastern capitalists. It is stated that the line between Greenwood and Shelbyville is to be constructed soon, and that the new stockholders have closed a contract by which its cars will use the Indianapolis, Greenwood & Franklin Company's tracks from Greenwood to Indianapolis.

INDIANAPOLIS, IND.—The South Bend & Southern Michigan Railway Company, incorporated under the laws of the state of Michigan, and the South Bend Northern Railway Company, an Indiana corporation, have filed articles of agreement in which a consolidation of the two lines is recorded. The two roads will, when they are completed, have a continuous electric line from South Bend, Ind., to St. Joseph, Mich. The capital stock of the consolidated lines is fixed at $750,000. The road is to be mortgaged to this amount and the money devoted to the extension and completion of the line. The board of directors of the road consists of James B. McCance, Mortimer P. Reed, F. W. Builtzinglowen, Demas D. Bates and William W. Babcock, who will conduct the affairs of the road until the election of a new board in November.

INDUSTRIAL ITEMS.

THE DUNCAN ELECTRIC MANUFACTURING COMPANY, La Fayette, Ind., has recently perfected a new type of meters for direct and alternating-current systems.

MR. CHARLES A. COTTON announces his removal to 129 Pearl street, Boston, Mass. Mr. Cotton is agent for the manufactures of the Triumph Electric Company, of Cincinnati, Ohio, and the Warren Electric Manufacturing Company, Sandusky, Ohio.

MR. H. ANDERSON, Peekskill, N. Y., has perfected and is placing on the market a unique magnet winder for hand or lathe winding or rewinding of all sizes of wire. This company also manufactures wire reels and measuring machines for measuring wire while winding.

MR. G. M. GEST, the well-known conduit contractor of New York city, has secured the contract for the conduit system for the Schenectady Railway Company, Schenectady, N. Y. This work will amount to over 200,000 feet. Many new features will be designed for this installation.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., is advising the lighting plants to push the sale of arc lamps as an advertising proposition among local merchants. In this connection the company makes the claim that the Adams-Bagnall arc lamp is eminently suited for this purpose.

SARGENT, CONANT & COMPANY, Boston, Mass., have secured the contract for the electric equipment of the Miller's Falls Paper Company, Miller's Falls, Mass. The mill will be electrically driven throughout, and the contract includes equipment covering motors, generators, and arc and incandescent lamps.

J. A. VAUGHN has recently established an office at 26 Cortlandt street for the representation of J. F. Buchanan & Company, dealers in electric lighting supplies. He is also acting as the New York agent for the Rittenhouse-Miller Company, of Philadelphia, Pa., in the introduction of the new Eureka flexible conduit.

THE WOLF COMPANY, Chambersburg, Pa., is distributing a handsome catalogue descriptive of flouring mill and power transmitting machinery. The book is copiously illustrated and describes in detail the wide range of apparatus manufactured by this company. This catalogue will be sent to any one interested upon application.

THE BUFFALO SPECIALTY MANUFACTURING COMPANY, 375 Ellicott street, Buffalo, N. Y., has obtained an exclusive license for the manufacture of the mast arm for arc lighting which has heretofore been manufactured by the White Star Appliance Company, of that city. This company expects to manufacture several new lines of electrical apparatus.

THE STANLEY ELECTRIC MANUFACTURING COMPANY, Pittsfield, Mass., is distributing bulletin No. 128, descriptive of the inductor alternator. A number of fine half-tones illustrate different types of the S. K. C. system. This interesting reading and instructive delineation may be had upon application to Mr. Ray D. Lillibridge, 170 Broadway, New York city.

THE PEERLESS LUBRICANT MANUFACTURING COMPANY, 117 Liberty street, manufactures the Peerless belt filler. This compound, it is claimed, permanently stops slipping of belts, contains no deleterious matter, and is a perfect preserver of the leather. This is packed for shipment in portions ranging from five pounds to one barrel lots. The company will be pleased to furnish complete information upon application.

THE BELL TELEPHONE MANUFACTURING COMPANY, Baraboo, Wis., was incorporated August 4, 1902, for the manufacture of telephone apparatus. This company assumes the business which has been conducted by the company formed through the partnership of Messrs. W. J. and F. E. Bell. The new officers of the company are as follows: W. J. Whistler, president; William J. Bell, secretary, and J. P. Witmer, treasurer.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., is sending out an ingenious device for displaying the colors of Dixon's silica graphite paint in such manner as will permit of an exact idea of each color. This color chart carries with it sug-

gestions as to the class of construction that can be protected with this paint, and also instructions as to the best way of applying protective paint. This chart can be secured by request to the company.

THE AKRON ELECTRICAL MANUFACTURING COMPANY, Akron, Ohio, manufacturer of generators, motors and electrical machinery, is distributing a pamphlet reprinting an interesting paper by Mr. F. B. Duncan, on "Electrical Equipment for Modern Machine-Shop Practice," recently delivered before the Engineers' Society of Western Pennsylvania. Accompanying the pamphlet is a handsome reproduction in colors of a standard Akron electrical motor.

DOUBLEDAY-HILL ELECTRIC COMPANY, electrical supply dealer, Pittsburg, Pa., has equipped the following towns with arc lamps of the new series alternating type made by the Adams-Bagnall Electric Company: Pitcairn, Dubois and New Kensington, and the new Union depot in Pittsburg. This company has also been given the agency for the Nernst lamps, and among other orders for Nernst lamp equipments it has recently been awarded the contract for the Conservatory of Music at Pittsburg, and the large store of Devoe, Clinton & Alexander.

F. H. LOVELL & COMPANY, New York city, are prepared to furnish everything in the electrical line, such as railway installations, special moulded insulations of all kinds for switchboards, as well as insulations for arc lamps, etc., where insulations requiring protection against high temperatures are necessary. The company also furnishes enclosed fuses for all classes of work, and the company's foundry supplies a line of brass castings in the way of ears, trolley rails, etc. Mr. A. Hall Berry, late with the H. W. Johns Company, is now general manager of the Lovell Company, and invites the correspondence of his old friends in this line.

THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, Pittsburg, Pa., has secured the contract for the entire electrical equipment of the Eureka Fire Hose Company, of Jersey City, N. J. This company has decided to discard its present equipment of direct-current power transmission, and to adopt an alternating-current system. The new apparatus includes one 75-kilowatt, belt-driven alternator, furnishing two-phase current at 7,200 alternations and 220 volts, with exciter switchboard equipment, slide rails, rheostats, etc. A number of induction motors, including five of fifteen horse-power, one of ten horse-power, five of five horse-power and three of two horse-power, have also been ordered. With this there will be furnished a switchboard feeder panel completely equipped with instruments and switches.

THE PROMETHEUS ELECTRIC COMPANY, 60 Reade street, New York city, reports that its "wireless" electric heating and cooking apparatus is finding much favor and that the public and central station managers are recognizing the excellence of these goods. This is evidenced by the number of orders which are being received daily and it is encouraging to note that throughout the country central stations are reducing the rates for current used for electric heating and cooking. Current employed for such purposes is used during hours of light load for domestic as well as industrial purposes. In view of the fact that the "Prometheus" system is so radically new in this country, and that few are aware of its great success throughout Europe, it is a sign of positive approval of the apparatus that the company is doing so large a business.

THE VOUGHT-BERGER COMPANY, La Crosse, Wis., maker of telephones and switchboards, has just moved into a large new manufacturing plant occupying three buildings, making its factory one of the largest of its kind in the country. Mr. Foley, formerly superintendent and purchasing agent of the Western Telephone Construction Company, has recently accepted a similar position with the Vought-Berger Company. Among switchboards and complete equipments recently sold are those for the Western Wisconsin Telephone Company, Arcadia, Wis.; Keister Telephone Company, Keister, Minn.; Alexander Telephone Company, Alexander, Iowa; a toll-board for the La Crosse Telephone Company; the People's Telephone Company, Houston, Minn.; Redwood County Rural Telephone Company, Redwood Falls, Minn.; Walnut Grove Telephone Association, Walnut Grove, Minn.; Farmers and Merchants' Mutual Telephone Company, of Le Suer and Rush River, Minn.; Harris-Jewell Telephone Company (pendent telephones used exclusively), Coon Rapids, Iowa; Victor Mutual Telephone Company, Harvey, Iowa; Havelock Telephone Company, Havelock, Iowa; Davis Telephone Company, Goodwater, Ala.; Golden Rod Telephone Company, for both Mead and Ceresco, Neb.

THE ALLIS-CHALMERS COMPANY, Chicago, Ill., reports the following partial list of engine sales for August, 1902: Armour Institute of Technology, Chicago, one 9 and 18 x 24-inch, 1890, cross-compound, Reynolds-Corliss engine; Bamberger Delmar Gold Mines Company, Utah, one 22 and 44 x 48-inch, 1890, cross-compound, Reynolds-Corliss engine, one 28 x 12-inch, Reynolds jet condenser and air pump; Interurban Construction Company, Ottumwa, Iowa, one 18 x 42-inch, 1890, Reynolds-Corliss engine; Sloss-Sheffield Steel and Iron Company, Birmingham, Ala., three vertical, standard, long cross-head, 44 and 84 x 60-inch blowing engines; Calumet & Arizona Mining Company, Douglas, Ariz., one 14 and 28 x 36-inch, tandem-compound, condensing, Reynolds-Corliss engine; one left-hand, low-pressure side, 40 and 44 x 48-inch, Reynolds-Corliss condensing blowing engine; Shattuck Brothers, Sparta, Wis., one 8 x 24-inch, girder, Reynolds-Corliss engine; City of Henderson, Henderson, Ky., one 24 x 48-inch, 1890, Reynolds-Corliss engine; Denver Tramway Power Company, Denver, Col., one 32 and 68 x 60-inch, 1890, cross-compound, condensing, Reynolds-Corliss engine, one 30 and 64 x 48-inch, 1890, cross-compound, condensing, Reynolds-Corliss engine; Detroit Copper and Brass Rolling Mills, Detroit, Mich., one 26 x 48-inch, 1890, Reynolds-Corliss engine; Southern Electric Light and Power Company, Philadelphia, Pa., one 42 and 86 x 60-inch, combined horizontal and vertical duplex, compound-condensing, Reynolds-Corliss engine; Horseshoe Mining Company, Deadwood, S. Dak., one 14 x 42-inch, 1890, Reynolds-Corliss engine, one 16 and 24 x 42-inch, 1890, tandem-compound, Reynolds-Corliss engine; E. H. Dyer & Company, Cleveland, Ohio, one 12 x 36-inch, girder, Reynolds-Corliss engine; Sanitary District of Chicago (for Thirty-ninth street pumping station), Chicago, two steam and two water ends for vertical, triple-expansion, pumping engine, one centrifugal drainage pump; City of Allegheny, Allegheny, Pa., one steam end and one water end for a five-million gallon, vertical, triple pumping engine; Pennsylvania Railroad Company, Pennsylvania, two Sederholm boilers, 384 horse-power.

THE NERNST ELECTRIC LIGHT, LIMITED, 82 Victoria street, London, England, is introducing the Nernst lamp into the territory which includes the whole of Asia, Africa and South America, and all the British colonies. The company has just issued a new illustrated catalogue and price list. This describes the types of lamps which the company is prepared to sell. The lamps are rated by current instead of the usual candle-power. The candle-power therefore depends on the voltage of the supply. As the lamps are made for three different currents—that is, 0.25, 0.5 and 1 ampere—it is always possible to get a lamp very near to the particular candle-power desired, the total range extending from 15 to 170 candles. The lamps are made for any voltage from 100 to 250. The high-voltage lamps are slightly superior in efficiency to those for lower voltages. The model "A," or large lamp, is used for all one-ampere lamps and for the high-voltage, one-half-ampere lamps. The lamp consists of three parts—the carrier, the lamp body and the globe. The mains are attached to contacts in the top of the carrier, whence the current is led by two flexible leads to insulated plug contacts, which fit on two pins in the lamp body. By pulling out these contacts, the lamp body and parts are rendered entirely dead, and may be handled with safety even though the lamp is not disconnected from the mains, thus allowing an easy method of replacement. The carrier is made for either screwing to gas fixtures, or may be arranged for either interior or outdoor use from a pendent hanger. The lamp case contains the magnetic cutout for interrupting the current through the heater when the glower lights, and also the socket for the series resistance. The distribution of light is very even and satisfactory. The model "B," or small lamp, is used for all the one-quarter-ampere lamps and for the low-voltage, one-half-ampere lamps. Careful tests of candle-power and efficiency of the one-quarter, one-half and one-ampere lamps for high voltage show that the candle-power is well kept up during the life and that the efficiency is hign, the consumption being less than two watts per candle-power on the average. The company claims that the first cost of Nernst lamps is very soon saved, and the item for current is constantly cut down. The company will mail its catalogue to any one interested upon request.